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RECENT CONTRIBUTIONS TO THE CHEMISTRY AND BACTERIOLOGY OF THE FERMENTATION INDUSTRIES.*

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LECTURE I.

ALTHOUGH the fermentation industries are among the most ancient and venerable of all the arts and manufactures which have engaged the attention of the human race, they are precisely those which have had to wait longest before being placed on a sound scientific basis. Of incalculably greater antiquity than such industries as the manufacture of acid and alkali, of glass, or of artificial colors, all of these have undergone a much more rapid development as regards the perfecting of the processes involved, through the light of scientific knowledge, than has been the case in the fermentation industries, in which, until recently, many of the operations were shrouded almost in the same darkness that enveloped them thousands of years before the commencement of the Christian era.

The cause of this more tardy development is not far to seek; it is obviously due to the fact that, while the ordinary chemical industries depend upon chemical and physical changes in comparatively simple substances, the fermentation industries owe their existence to those far more subtile changes which are realizable through the intervention of what we now generally call "living protoplasm," which was, until long after the beginning of this century, believed to be subject to entirely different laws from those governing the inanimate creation, and to be capable of bringing about changes through the mysterious agency known as "vital force."

But, although the first great wave of scientific discovery in the domain of organic chemistry, which marked the second quarter of the present century, succeeded in demolishing this phantom of vital force, by showing that substances which were only found in nature as the products of animal or vegetable life could also be produced artificially in the laboratory, yet, owing to the great complexity of most of these vital products, and the great experimental difficulties which generally attend their investigation, it is only natural that the progress of our knowledge concerning them should have been comparatively slow.

Thus, notwithstanding that one of the simplest—although most important—of these vital products, *urea*, was first artificially obtained as early as the year 1832 by Wohler, it is only within the last few years that even vital products of such comparative simplicity as the sugars have been artificially obtained by Emil Fischer, who has been assisted in their production by the practical experience and theoretical speculations of fifty years of unparalleled activity in every department of science.

It is sufficiently evident, therefore, that the accurate study of vital products is attended with great difficulties, and moves forward but slowly; and, on these grounds, we should anticipate that scientific progress in connection with the fermentation industries would be slow also. But there is a further difficulty attaching to their study, for the living organisms upon the vital activity of which these industries depend are so minute that their careful investigation has had to wait for the development of an elaborate technique which it has taken years and the ingenuity of numerous gifted experimenters to perfect. Thus microscopes of great power and special construction have had to be devised in order to render them distinctly visible, but owing to the only very slight differences in appearance which are exhibited by many of these minute organisms when viewed under the most powerful lenses, mere microscopic examination has proved quite inadequate to distinguish between them in most cases, so that supplementary study by culture, that is to say, by growing them in suitable media, has during recent years been more and more resorted to.

This study by culture, again, is attended with great difficulties, because, owing to the almost universal distribution of these minute organisms in all our surroundings, there is the continual danger of the forms we wish to study becoming mixed or contaminated with other forms accidentally introduced. Now, it is just in this direction of obtaining and maintaining what are known as pure cultures that such great strides have been made in recent years, and which have enabled the study of these minute forms of life to be prosecuted with accuracy and precision.

The operations connected with the study of these micro-organisms are of such a specialized character that this study may conveniently be regarded as a separate science in itself, to which we now generally give the name of bacteriology, although, of course, it really consists in the application of numerous sciences, such as physics, chemistry, botany, etc., to the study of the phenomena exhibited by these microscopic forms of life.

We will endeavor, in this first lecture, to make ourselves acquainted with some of the more important methods of study which have yielded such abundant fruit during recent years in all departments of bacteriology.

* *From the Journal of the Society of Arts.*

MICROSCOPIC EXAMINATION.

The older methods of examining a material for micro-organisms consisted in simply transferring some to a clean cover glass, mixing, if necessary, with a little water, and then examining under a high power of the microscope. In this way the organisms can be seen in the living state, but owing to evaporation from the edge of the cover glass, disturbing currents in the liquid are produced, while the whole soon becomes dried up, and further observation is thus rendered impossible.

In order to obviate these disadvantages, and especially to render observation in the natural and living

FIG. 1.—SUSPENDED DROP CULTURE.

A, glass slide; B, cover glass; C, glass ring forming the wall of the chamber; P, drop of nourishing material in which the micro-organisms grow.

state possible over hours, days or even weeks, the device has been resorted to of cultivating in a suspended drop of nutritive liquid.

In this manner the complete life history of a micro-organism, from its cradle to the grave, can be watched. Seen under these circumstances some micro-organisms are found to be possessed of mobility while others are stationary. Again in this way the marvelous rapidity of multiplication exhibited by some micro-organisms has been determined; thus in the case of one bacillus it has been found that division into two takes place in as little as twenty minutes.

STAINING OF BACTERIA.

The great advances which have been made in our knowledge of micro-organisms within recent years are largely due to the methods which have been devised

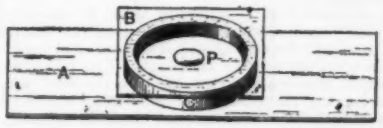


FIG. 1A.—SUSPENDED DROP CULTURE.

A, glass slide; B, cover glass; C, glass ring forming the wall of the chamber; P, drop of nourishing material in which the micro-organisms grow. (After Klein.)

for accentuating their appearance by means of brilliant colors. Striking colors are employed by both the savage and the civilized man, or rather woman, to render themselves more conspicuous, in the latter case by clothing in colored garments, while by the savage the process of brilliantly coloring the body itself is adopted. Now this is also the process employed by bacteriologists to render micro-organisms conspicuous among their surroundings. The bodies of these micro-organisms are dyed, and the dyeing is carried out on the same principles as the dyeing of a skein of silk or a hank of wool.

These textile fibers, silk and wool, as is well known to dyers, are most readily colored by what are called the basic coloring matters, to which group belong the brilliant aniline dyes, like magenta, methyl violet,

FIG. 2.—BACILLUS SUBTILIS, SHOWING TRANSVERSE DIVISION. (After Klein.)

malachite green, etc. The great advantage of these dyes consists in the rapidity and intensity with which they color the materials for which they have an affinity.

It must not be supposed that all materials have an affinity for or can be dyed by these basic aniline colors, and the following experiment will serve to show how their affinity for the substances of which micro-organisms are composed enables these to be distinguished among their surroundings.

[Experiment.—Dyeing of silk and wool, which have been stitched through piece of calico, by immersion in dilute solution of magenta; on subsequent washing with water, the color is removed from the calico (cotton), while the silk and wool remain permanently colored.]

In most cases, however, the staining of micro-organisms is not such a simple matter as this, for the bodies with which they are surrounded have also generally a strong affinity for these basic colors, which results in these bodies becoming also dyed with the color employed.

There is, however, a peculiarity about these micro-organisms which enables us to strongly dye them while leaving the surrounding matters colorless or only faintly tinged. The micro-organisms, in fact, appear to be invested with an envelope which offers great obstacles to the penetration of the coloring matter to their interior. This envelope of the micro-organisms, however, serves to protect them from influences which readily affect bodies not so surrounded, and it is this circumstance which is taken advantage of in various ways in the dyeing or staining of micro-organisms. Thus one of the simplest and most commonly practiced expedients consists in exposing the micro-organisms and the materials with which they are mixed to such a temperature that, while the other materials are so scorched by the heat that they are no longer capable of being dyed, the micro-organisms, wrapped in their protecting blanket, so to speak, suffer, practically, no injury. On now applying the dye to the scorched specimen, the micro-organisms become strongly and permanently colored, while the surrounding matters remain colorless.

You might think that it was very difficult to apply heat so delicately adjusted as to injure these other materials without affecting the micro-organisms, but as a matter of fact, with a little experience it can be done with great readiness and facility.

[Demonstration of preparation of scorched cover glass with subsequent dyeing.]

In this manner, or by subsequently removing the dye from the surrounding materials by means of acids, the most beautiful microscopic preparations of micro-organisms can be obtained. Some idea of the appearance of these I can convey to you by means of the following colored slides and diagrams.

[Demonstration of slides and diagrams of stained micro-organisms: Spirilla of Asiatic cholera, typhoid bacilli, micrococci of erysipelas, yeast, etc.]

The examination of the stained micro-organisms, dyed as I have described, sometimes reveals the presence within the micro-organisms of small round or oval bodies which have not taken up the coloring matter. These bodies, shown in the following figures, are the

FIG. 3.

A, spores magnified 700 times; B, spores and bacilli containing spores magnified 1,650 times.

so-called spores, which, in consequence of their great power of resisting destruction, are of such tremendous importance in the propagation of some micro-organisms.

Although sufficiently conspicuous by the fact of their not sharing in the gay colors which have been bestowed on the micro-organisms themselves, bacteriological artists are, nevertheless, fond of painting them also, which can be done by a little modification of the process I have described. To this end the preparation containing spores is dyed, not with an aqueous solution of one of the basic coloring matters, but with a solution of the coloring matter in aniline water, which gives the dye a greater power of penetration. In this manner even the spores become dyed, and, *a fortiori*, the fully developed micro-organisms also. The coloring matter having penetrated into the interior of the spores, is there much more firmly fixed than elsewhere in the preparation, so that if we now submit the latter to a decolorizing process by a submersion in dilute nitric acid (1:3), the color will be last removed from the spores.

[Demonstration of decoloration of magenta by dilute nitric acid (1:10).]

Having then removed the color by means of dilute acid from everything excepting the spores, we proceed to redye the fully developed micro-organisms by means of another color in the ordinary way. In this manner a beautiful and most effective microscopic preparation is obtained, in which the spores are tinted with one color and the fully developed organisms with another, as in the following slide:

[Demonstration of *Bacillus subtilis*, with spores stained in one color and the bacilli in another.]

It is a highly remarkable phenomenon, that some fully formed micro-organisms offer the same difficulties in the way of being stained as do the spores. This is notably the case with one of the most important of all the micro-organisms with which we are acquainted, viz., the tubercle bacillus. The great value of detecting this bacillus for clinical purposes has led to a number of methods being devised for rendering them apparent through staining. These methods are based on essentially the same principles as those which I have described for the staining of spores.

[Demonstration of slide of tubercle bacilli in giant cell, the bacilli stained with methylene blue, the nuclei of the giant cell with Bismarck brown.]

The refinements of microscopic *technique*, in connection with micro-organisms, have, however, gone even beyond what I have yet described; for none of the methods of staining already mentioned are successful in displaying certain highly important structures possessed by some forms, viz., the organs of locomotion, by means of which some, at least, of the motile microbes are able to propel themselves about in liquid media, often with fabulous rapidity. These organs of locomotion, unlike either the bodies or the spores of micro-organisms, have no affinity for these aniline colors, which we have seen are so useful in exhibiting the latter. In the practice of dyeing textile fibers we are also acquainted with fibers which exhibit the same indifference to these colors; thus, cotton and linen cannot be directly dyed with the basic aniline colors, and, in order to dye them with these colors, we have, in the first instance, to prepare these fibers, by impregnating them with what are known as mordants.

[Experiment.—Cotton not dyed by solution of magenta, but cotton previously mordanted with tannin, takes the dye readily and permanently.]

Now, this is essentially the principle on which it has been found possible to demonstrate in the most beautiful way the existence of organs of locomotion in the case of motile micro-organisms.

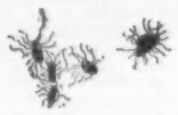


FIG. 4.—TYPHOID BACILLI, SHOWING THE FLAGELLA, OR ORGANS OF LOCOMOTION. (After Migula.)

It will thus be seen that we are now provided with numerous appliances for carefully studying the form of micro-organisms. Indeed, with the best modern microscopes, and by carefully staining, their outlines are so sharply distinguishable that the most beautiful photographic representations of these minute forms of life are obtainable.

CULTIVATION OF MICRO-ORGANISMS.

Although great strides have been made in the methods of examining micro-organisms microscopically these improvements are really of far less importance than those which have been introduced in the study of these organisms by growth, or culture, as it is termed.

The cultivation of micro-organisms has become a matter of such many-sided interest and consequence, that it is impossible to discuss any questions connected with fermentation and other processes in which micro-organisms are concerned without a knowledge of the principal methods which are employed in their cultivation. We shall, therefore, be obliged to speak of these in some detail.

For the cultivation of all micro-organisms, more or less moist materials are necessary, both liquids and solids being employed for the purpose. It might be supposed that it would be easy to find a medium which would suit the requirements of all micro-organisms, since, from some points of view, they are all so similar; but, as a matter of fact, there is the greatest diversity in their tastes, and media which are suitable for the growth of some are utterly unfitted for the cultivation of others. Thus, while some organisms are unable to thrive and multiply excepting when surrounded with the most nutritious and subtile foodstuffs, others absolutely refuse to grow unless bathed in a liquid from which such organic materials have been most carefully banished. The ingenuity of the bacteriologist is, in fact, severely tried in endeavoring to cater for the organisms which he has under his charge, and every year or even month sees many additions to the *menu* from which he has to select, and which already includes such a medley as living animals, blood serum, bouillon, beef jelly, agar-agar, potatoes, bread, malt wort, numerous purely mineral solutions, etc.

Whatever medium we may be employing, it is, before all things, necessary that it should be deprived of every form of living matter, so that only those organisms which we purposely introduce may be nourished and fostered. In the language of bacteriologists, the medium must be sterilized. This sterilization may be effected in various ways.

1. The medium may be naturally sterile or devoid of living matter, and in this case we have only to prevent the accidental introduction of living germs during manipulation. This is notably the case with blood serum; the blood of healthy animals is free from micro-organisms, and if, before inflicting a wound, the surface of the body be disinfected, and the blood carefully collected in sterile vessels, it will remain sterile, and the serum which separates can be further transferred to sterile vessels, which, if adequately protected from the access of living germs, will remain sterile and unchanged for an indefinite period of time.

2. More commonly we employ the agency of heat to effect the destruction of the living organisms which may be accidentally present in our culture media; the most convenient mode of applying the heat being by means of steam, as can be done in the piece of apparatus represented in Fig. 5, and which is generally termed a steam sterilizer.

In order that this steaming may be certainly effectual, it is necessary that it should be continued for from half to one hour, which would seriously impair the qualities of some of the culture media we employ.

This difficulty is overcome by means of what is called discontinuous or fractional sterilization. It is found, in fact, that if a medium is repeatedly steamed on several days for a few minutes each day, it is as effectually sterilized as if it had been continuously steamed on one occasion for a long period of time. This phenomenon is generally explained on the assumption that the few minutes' steaming kills all organisms excepting spores, and that by allowing a day to intervene between the first steaming and the second, an opportunity is given to these spores to germinate, so that at the second steaming the fully developed organisms, to which the spores have thus given rise, will be killed also. A third steaming is generally superadded to insure the process of destruction being completed. It is, however, in my opinion, far more probable that the effectiveness of the discontinuous application of heat depends upon the destructive action of the temperature being rapidly raised to the boiling point, and that the repeated raising of the temperature is far more fatal than if the high temperature is merely maintained over the same period of time. This discontinuous steaming is particularly necessary for the sterilization of nutritive media containing gelatine as prolonged steaming greatly reduces the melting point of the gelatine.

3. Discontinuous or fractional heating may be made a means of effectual sterilization even without employing a temperature as high as that of boiling water. Thus milk should be sterilized by heating it on four or

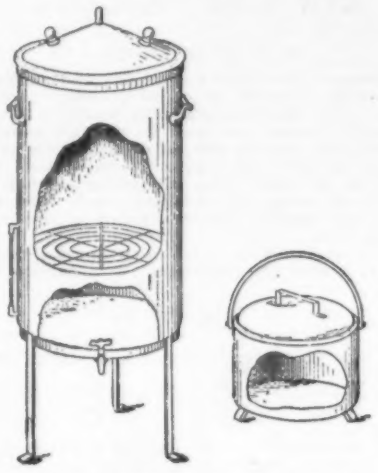


FIG. 5.—STEAM STERILIZER.

five successive days for one hour on each day to 65–70° C. or 150–160° F., for in so doing the chemical character of the milk is not changed, as at this temperature the albumen is not coagulated as would be the case if it were heated above 75° C. or 167° F. This fractional sterilization, which was originally devised by Tyndall, is one of the most important points in practical bacteriology.

The importance of the sterilization of milk has become so manifest that on the Continent it is now sometimes actually carried out on an industrial scale, and numerous forms of apparatus have been devised for effecting it.

The difficulty of preserving milk is equally felt by both dairyman and consumer; and the former frequently resorts to chemical additions of a very doubtful character to secure this end. The additions most commonly made are carbonate of soda and borax, the former having the effect of neutralizing the lactic acid, which causes the souring and curdling of milk, while the borax exerts an antiseptic action, and thus prevents the growth and multiplication of micro-organisms, which bring about changes in the milk.

Far preferable is the preservation of milk through heat, for in this way also pathogenic organisms, which are liable to be present at any time in this excellent culture medium, are also destroyed. In Germany this industrial sterilization of milk has been carried on for some years, by means of Thiel's apparatus, in which

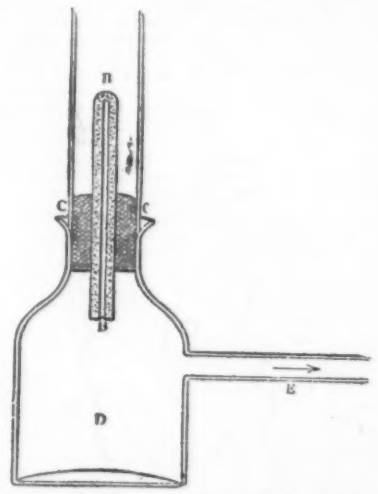


FIG. 6.—PORCELAIN OR CHAMBERLAND FILTER.

A, glass cylinder in which the liquid to be filtered is placed. BB, porous porcelain hollow cylinder, passing tightly through india rubber stopper (CC), which also fits the strong glass bottle (D) into which the filtrate passes, and in which a partial vacuum can be produced by connecting the side tube (E) with a pump.

the milk is passed over a heated corrugated metallic surface which rapidly raises its temperature to 75–85° C., after which it is promptly cooled down to 10–12° C., by means of a refrigerator. More recently, Soxhlet has devised a method of preparing milk—more especially for infants—by heating in separate flasks to upward of 75° C.; the flasks are then tightly corked, the heat being maintained a little longer, after which they are cooled. The milk thus treated is not necessarily or generally sterilized, for milk often contains just those microbes which are most difficult to destroy, and which have gained access from hay dust or the like. Owing, however, to the greater number of the microbes having been killed, it keeps better, and, most important of all, the pathogenic organisms will have been destroyed with almost perfect certainty. The importance of this latter point is sufficiently evident, without considering the occasional communication of the ordinary zymotic diseases through milk, when we bear in mind the frequency of tuberculosis among cows. Thus in the slaughter houses of Silesia it has been found that the following proportions of the cattle are affected by tuberculosis:

Calves	0·13 per cent.
Bulls	1·00 "
Young beasts	1·87 "
Oxen	7·31 "
Cows	9·54 "

Although it is highly desirable that such a sterilized milk industry should be established in this country, it is undoubtedly a still more satisfactory safeguard for the consumer himself to submit the milk to boiling before use.

4. After this digression we pass to another method of sterilization, which has recently become of very great service where the application of heat is inadmissible, and which consists in filtration through porous porcelain under pressure, as shown in Fig. 6.

This method is of course only available in the case of liquids, and is of special value in the investigation of the products generated by micro-organisms, in which it is desired to separate the products from the organisms, as many of these products are destroyed or altered by high temperatures.

It is by the use of this arrangement that the various soluble ferments frequently generated by micro-organisms have been isolated, and it has been of special service in separating pathogenic organisms from the soluble toxic substances to which they often give rise during their growth.

BISULPHITE OF SODA: ITS USES AND VALUATION.

By C. F. S. ROTHWELL, F.C.S.

BISULPHITE of soda is chiefly required by dyers for making hydro-sulphite of soda to be used for reducing indigo, and by calico printers for the formation of the bisulphite compounds of the dyes belonging to the cærulein and alizarine blue class, which are thus rendered soluble. It comes into the market usually as an aqueous solution of about 50° Tw.; but some makers send out stronger solutions than this. These solutions vary very much in their composition, not only in the amount of sulphurous acid and alkaline base they contain, but also in the manner in which the sulphurous acid is combined. This is a very important point, because two lots may contain the same actual percentage of sulphurous acid, yet one may be quite unsuitable for a purpose for which the other has been regularly used and is perfectly fitted. Two instances where this has been the case have come under my notice.

For the reduction of indigo only that portion of the sulphurous acid is utilized which is in the free state, together with half of that combined as bisulphite of soda in the solution. Neutral sulphite of soda is *practically* useless to the indigo dipper. Consequently, on setting free that portion of the sulphurous acid which is combined with the soda by adding the calculated quantity of dilute sulphuric acid, nearly the whole of the sulphurous acid can be rendered available. But if the sulphuric acid be added to the bisulphite, directly large quantities of sulphurous acid are evolved and escape into atmosphere, causing not only considerable waste, but much annoyance to the workmen. For this reason it should be added gradually after all the zinc powder has been stirred in. As the sulphuric acid will neutralize a quantity of lime chemically equivalent to it, this should be added in addition to that usually used or, preferably, an equivalent weight of caustic soda dissolved in water. From these remarks it will be understood why, if one sample contains a large quantity of its sulphurous acid in the form of neutral sulphite of soda, notwithstanding the fact that its percentage of sulphurous acid is the same as another sample, the former would be of much less value to the indigo dyer than the latter, unless the sulphurous acid in it was liberated with sulphuric acid as described. Hence if the bisulphite of soda is to be used by indigo dippers, we require to know not only the quantity of sulphurous acid which it contains, but also the manner in which it is combined or exists in the solution. When the bisulphite is to be used for rendering soluble dyes like cærulein, etc., a sample should be chosen containing as much as possible of its sulphurous acid combined with soda in the form of bisulphite of soda; an excess of free acid is preferable to having neutral sulphite of soda in the solution.

Having now pointed out the importance of a knowledge of the manner in which the sulphurous acid is combined, I will describe methods for accurately determining this, together with the total quantity of sulphurous acid. The time taken to carry out these determinations is considerably under an hour, provided the standard solutions are already prepared.

Specific Gravity and Degree on the Twaddell Scale.—The density is determined at 60° F. by means of the ordinary Twaddell hydrometer, and from this the specific gravity is calculated by multiplying by 5 and adding 1,000. Thus, say the sample marked 50° Tw., then $50 \times 5 + 1{,}000 = 1{,}250$, which is the specific gravity of the solution compared with water as 1,000. But usually water is taken as one, so that $\frac{1250}{1000} = 1{\cdot}250$ is the specific gravity, taking water as the unit. Consequently one cubic centimeter of the solution will weigh 1·250 grammes.

Total Sulphurous Acid.—Take about 7 grammes or, more conveniently, 5 c. c. of the sample; place it in a half liter graduated flask and dilute it with boiled and cooled water up to the mark on the neck, and shake well, so as to render the mixture homogeneous. Twenty-five cubic centimeters of this solution are measured and mixed with about 500 c. c. of boiled and cooled water in a white porcelain basin. A little weak filtered starch solution is then added and decinormal iodine solution is slowly run in from a burette until the blue color which forms round each drop of the iodine solution as it touches the solution is permanent, and the whole solution has a pure blue color. Toward

the end of the reaction, which is indicated by the blue color being destroyed only gradually as the solution is mixed, the iodine should be added drop by drop, stirring thoroughly between each addition. The starch solution is made by working about half a gramme of wheat starch into a cream with water, pouring about 70 c. c. of boiling water over it, and filtering the solution. On no account should this solution be used without filtration, as the end reaction is never as distinct in this case. If the operator has a knowledge of quantitative analysis, he will be acquainted already with the method of making a decinormal solution of iodine; in the other case he can purchase some from any laboratory furnisher, or prepare it according to the directions contained in Thorpe's *Quantitative Analysis*, Sutton's *Volumetric Analysis*, or Mill's and North's *Quantitative Analysis*. The water used is well boiled to expel all the air (which would oxidize some of the sulphurous acid) and then allowed to cool in a bottle filled quite up to the neck and provided with a loosely fitting cork. The method of calculating the percentage of sulphurous acid can best be shown by taking an example: Sample indicated 47° Tw., equal to 1·235 specific gravity. Five cubic centimeters, equal $1{\cdot}235 \times 5 = 6{\cdot}175$ grammes, were made up to 500 c. c., and 25 c. c. of this solution (*i. e.* $\frac{1}{20}$ of it) required 15·5 c. c. of decinormal iodine solution. One cubic centimeter of decinormal iodine solution oxidizes, and consequently indicates, 0·0032 gramme of sulphur dioxide; hence the 25 c. c. of the solution used in the test contained $0{\cdot}0032 \times 15{\cdot}5 = 0{\cdot}0496$ gramme of SO_2. As the 25 c. c. contained $\frac{6{\cdot}175}{20} = 0{\cdot}30875$ gramme of the sample, the percentage of SO_2 is

$$\frac{0{\cdot}0496 \times 100}{0{\cdot}30875} = 16{\cdot}0 \text{ per cent.}$$

Free Sulphurous Acid and Half of that Combined as Bisulphite of Soda.—Take 10 c. c. of the sample, place in a flask, add 200 c. c. of water and an excess of neutralized hydrogen peroxide solution, and allow to stand for a few minutes in order to oxidize the sulphurous acid and sulphites into sulphuric acid and sulphates. Commercial hydrogen peroxide is generally acid, and it should be neutralized before use, and this is best done by adding a little of an alcoholic solution of phenolphthalein and afterward adding standard soda solution from a burette until the hydrogen peroxide just takes a permanent pink color. After the bisulphite solution has stood with the peroxide a few minutes, phenol-phthalein is added and then titrated with normal caustic soda solution until it just turns pink. From the data obtained the SO_2 in the free state and half of that combined as bisulphite can be calculated in the following way: Ten cubic centimeters of the sample used above weigh $1{\cdot}235 \times 10 = 12{\cdot}35$ grammes and they require 33·7 c. c. of normal caustic soda for neutralization. One cubic centimeter of normal soda neutralizes 0·032 gramme of SO_2; hence the 10 c. c. of the sample contained $0{\cdot}032 \times 33{\cdot}7 = 1{\cdot}0784$ grammes of SO_2 in the condition named, or $\frac{1{\cdot}0784 \times 100}{12{\cdot}35} = 8{\cdot}73$ per cent. It is absolutely essential to add the hydrogen peroxide before titrating, so as to oxidize the sulphurous acid into sulphuric acid, because sulphite of soda, unlike sulphate of soda, has a slightly alkaline reaction, and would, consequently, detract from the accuracy of the test. Methyl orange is recommended by some chemists as an indicator when titrating the free sulphurous in bisulphite of soda acid, but my experience with it is that the end reaction is by no means sharp enough, whatever the dilution of the liquor, and this I find is also the experience of many analysts with whom I have come in contact.

From the figures obtained as above, the condition in which the sulphurous acid is combined in the sample can be found. The titration with iodine indicates, as stated above, the total SO_2. Titration with caustic soda gives the SO_2 in the free state, and one-half of that existing as bisulphite, as shown by the following equation:

(*a*) $H_2SO_3 + 2NaOH = Na_2SO_3 + 2H_2O$
(*b*) $NaHSO_3 + NaOH = Na_2SO_3 + H_2O$

(Oxidation with the H_2O_2 is here disregarded, but it makes no difference in the results.)

Now by subtracting the SO_2 indicated by the caustic soda from the total SO_2, half the amount of SO_2 combined as bisulphite, together with the whole of that combined as neutral sulphite of soda, is left. If the sample contains free SO_2, the amount indicated by titration with caustic soda will exceed the difference between it and the total SO_2. If it does not, then the sample contains neutral sulphite of soda. The following examples will make the calculation clear in case of the sample containing either free acid or an excess of neutral sulphite.

Example I. (sample containing free sulphurous acid)

Total SO_2	16·00 per cent.	$= a$
SO_2 as bisulphite and free (if any)	8·73 per cent.	$= b$
Half the SO_2 as bisulphite + any as neutral sulphite	7·27 per cent.	$= c$

Since b is greater than c, free SO_2 must be present, and consequently c is half the amount of SO_2 combined as bisulphite; hence the total amount is $7{\cdot}27 \times 2 = 14{\cdot}54$ per cent.

The difference between this number (14·54 per cent.) and the total SO_2 indicates the free SO_2; hence 16·00—14·54 = 1·46 per cent. of free SO_2. Thus the sample contains:

Total SO_2	16·00 per cent.
Combined as follows:	
Free SO_2	1·46 per cent.
As bisulphite of soda	14·54 per cent.

Example II. (containing neutral sulphite of soda)

Total sulphur dioxide	17·27 per cent.	$= a$
Sulphur dioxide as bisulphite and free if any	8·07 per cent.	$= b$
Half the SO_2 as bisulphite + any as neutral sulphite	9·20 per cent.	$= c$

As c here is greater than b, the sample, then, must contain neutral sulphite of soda, and the amount so existing in the solution is found by subtracting b from c thus: 9·20—8·07 = 1·13 per cent. of sulphur dioxide as neutral sulphite of soda. As there is no free SO_2, b indicates the amount of SO_2 as bisulphite of soda, the total amount is $8{\cdot}07 \times 2 = 16{\cdot}14$ per cent.

This sample has the following composition:

Total sulphur dioxide	17·27 per cent.
combined as under	
As bisulphite of soda	16·14 per cent.
As sulphite of soda	1·13 per cent.

Commercial bisulphite of soda generally contains an excess of sulphur dioxide or of alkali. For most of the uses to which it is put by dyers and calico printers, an excess of sulphur dioxide is preferable to an excess of alkali.

CHEMICAL EXAMINATION OF WRITING INKS.

By A. ROBERTSON and J. HOFMANN.

THE authors draw lines across the letters or figures with quill pens dipped in the following reagents, and observe the changes where the ink and the reagent meet, using, if needful, a magnifying power of 100 diameters. The reagents are: (1) A 3 per cent. solution of oxalic acid; (2) a 10 per cent. solution of tartaric acid; (3) a 2 per cent. solution of chloride of lime; (4) solution of 1 part stannous chloride in 1 part hydrochloric acid and 10 parts of water; (5) sulphuric acid at 15 per cent.; (6) hydrochloric acid at 10 per cent.; (7) nitric at 20 per cent.; (8) saturated solution of sulphur dioxide; (9) 4 per cent. solution of gold chloride; (10) solution of 1 part potassium ferrocyanide in 1 part hydrochloric acid and 10 parts water; (11) solution of 1 part sodium thiosulphate (hyposulphite) in 1 part ammonia and 10 parts water; (12) 4 per cent. soda lye.

Reagents.	Iron and gall ink.	Logwood with—		Nigrosine.	Vanadium ink.	Resorcin ink.
		Potassium chromate.	Copper sulphate.			
Oxalic acid	Disappears.	Violet.	Orange.	No change.	Turns pale and runs a little.	Bright red.
Citric acid	Turns pale.	Violet.	Orange.	Runs dark blue.	Turns pale and runs.	Disappears.
HCl	Disappears, but leaves a yellow.	Purple red.	Blood red.	Little change.	Slightly paler and runs slightly.	Light rose.
Sulphuric acid	Disappears.	Red.	Purple red.	No change.	Slightly paler.	Bright red.
Nitric acid	Disappears.	Red.	Purple red.	Runs slightly.	Slightly paler.	Light rose.
Stannous chloride	Disappears.	Red.	Magenta.	No change.	Slightly paler.	Disappears.
Sulphurous acid	Turns pale.	Violet gray.	Red.	No change.	Slightly paler and runs.	Turns paler.
Gold chloride	Slightly paler.	Red brown.	Brown.	No change.	No change.	Runs brown.
Sodium thiosulphate and NH$_3$	Dark red.	No change.	Dark blue.	Dark violet, runs.	Runs much.	Brown.
Ferrocyanide and HCl	Blue.	Red.	Brick red.	No change.	No change.	Rose.
Sodium hydroxide	Dark red.	Brown.	Dark red, runs.	Dark violet, runs.	Dirty brown, runs.	No change.
Chloride of lime	Disappears.	Disappears.	Disappears leaving a yellow stain.	Brown.	No change.	Brown.

The subjoined table shows the results. The results with tartaric acid are not tabulated.—*Chemiker Zeitung.*

THE ACTIVE ALBUMEN IN PLANTS.*

By O. LOEW.

ONE of the most important chemical functions of plant cells is that synthesis of albuminous matter which serves for the formation of protoplasm. The *living* protoplasm, however, is composed of proteids entirely different from the ordinary soluble proteids, as well as from the proteids of *dead* protoplasm. In other words, if living protoplasm dies, the albuminous constituents change their chemical character. We observe that in the living state a faculty of autoxidation (respiration) exists which is wanting in the dead condition; and Pflüger, in 1875, drew from this the conclusion that in protoplasm the chemical constitution of the living proteids changes at the moment of death.

Various other considerations force us to accept this logical conclusion. Chemical changes readily occur in all those organic compounds that are of a *labile* character. There exist so-called labile atom constellations that are in lively motion, and are thus prone to undergo change, the atoms falling into new arrangements which present more stable constellations. We do not doubt that *vital force is a mode of motion* due to the presence of atoms in labile positions in the albuminous substance. The motion ceases when there occurs a migration of the labile atoms to some stable position. The aldehydes give us fine illustrations of labile combinations and stable rearrangements in other allied substances.

The question now arises, can we chemically demonstrate that the albuminous substance formed by synthesis in plants is—*even before it has become protoplasm*—different from ordinary albumen? It was known long ago that the juice of plants—that is the aqueous solution in the vacuoles of the cells—contains albumen, but it was thought to be ordinary albumen. It is easy to prove that this is not the case.†

On treating living plant cells with dilute solutions of ammonia or organic bases or their salts, remarkable changes are observed. These consist either in the formation of numerous minute granules, as is the case on the application of most of the bases, or in the production of little globules flowing together to make relatively large drops of a substance of high refractory power, as is the case on the application of weak bases like caffeine or antipyrine.‡ These latter two bases in weak solution do not injuriously affect the protoplasm itself, since the cells will keep alive for a number of days in a 0·5 per cent. solution of these bases; the cells are, however, soon killed by other bases and their salts. The granules and globules formed in the living cells by the action of caffeine have been called by Bokorny and myself *proteosomes*. They give the principal reactions of albuminous bodies, but contain in most cases an admixture of small quantities of lecithin and tannin. These admixtures, however, can be removed by cultivating the objects (the alga, spirogyra, for instance) in solutions rich in nitrates.

If now by such cultivation the tannin has been removed and the proteosomes then produced by treatment with caffeine, we can observe that these albuminous proteosomes are capable of reducing silver from even highly diluted alkaline solutions. This property is lost after treatment with dilute acids as well as after the death of the cells.* In these cases the proteosomes become hollow and turbid, their substance appearing to coagulate and shrink.

There are thus experimental grounds for the conclusion that not only the organized albumen of the living protoplasm, but also the albumen dissolved in the vacuoles—the unorganized albumen—is a different substance from the ordinary albumen, which is present in dead cells. We may sum up the line of argument as follows:

1. Bases act upon the albumen of living cells; not, however, upon that of dead cells, nor upon ordinary dissolved albumen.

2. The action may be observed microscopically to take place in the case of various vegetable objects, in the liquid portion of the protoplasm itself as well as in the vacuoles. This can be specially well observed with the alga spirogyra when treated with caffeine.

3. The granules and globules into which the active albumen aggregates by the action of bases—called by us proteosomes—have the property of reducing dilute silver solutions in the absence of light, and lose this property by the action of acids.

4. The active albumen in its most *unchanged* condition can be made visible by caffeine or antipyrine, two bases that do not act as serious poisons to the cells. Living cells containing proteosomes, brought out by caffeine, when placed in distilled water regain their original condition, the proteosomes become gradually dissolved again (rapidly at 25° C.), and a new application of caffeine will now make them reappear.

5. If proteosomes are produced by caffeine or antipyrine, and the death of the cells is then caused by ether vapor, etc., it may be easily observed that soon after the death of the protoplasm the proteosomes of the vacuoles are also changed in their optical and chemical properties: they become turbid and hollow, they coagulate, and they lose their property of being resoluble in distilled water.

* Paper read before the Liège meeting of the International Congress of Physiologists.—Reprinted from *Nature*.

† O. Loew und Th. Bokorny, *Bioloy. Centralblatt*, xi., 1.

‡ These globules closely resemble the aggregated masses that Darwin observed after irritation of leaves of Drosera.

* The proteosomes produced by ammonia and various other bases preserve this property for a much longer time after the death of the cell than those produced by caffeine or antipyrine.

CHEMISTRY OF DIGESTION.

DR. A. L. GILLESPIE points out that, though hydrochloric acid is a powerful antiseptic and capable, in dilutions of 0·1 to 0·2 per cent., of inhibiting or destroying most minute organisms, the addition of proteid matter to it, and formation of what he terms proteid-hydrochlorides in the process of digestion, allows the same organisms to flourish luxuriantly, though the strength in acidity be maintained. After a meal consisting largely of proteids, generally an hour elapses before the advent of free hydrochloric acid, and the gastric juice is therefore much less antiseptic than after a meal of carbohydrate material. It is suggested accordingly that, since a typhoid or other pathogenic bacillus ingested during a heavy dinner has a more favorable opportunity for development than if it were taken with such food as porridge, it would be well if there were any danger of poisoning by disease germs to take nothing with a proteid meal except it had been thoroughly cooked, or, as alternatives, to live chiefly on carbohydrates, or to take some dilute hydrochloric acid after each meal.—*Medical Magazine.*

CHEMISTRY AND PALÆONTOLOGY.

A NOVEL application of chemical analysis was recently explained by A. Carnot, at the Paris Academy of Sciences. He has endeavored to fix the age of prehistoric human remains by noting the progressive diminution of fluorine in the fossil bones of successive geological ages. Representing the proportion found in the oldest specimens by 1, that of the tertiary remains would be indicated by 0·64, of the quaternary by 0·35, and of the more recent bones by 0·5 or 0·6. An

opportunity of testing the value of these figures was afforded by the discovery of a human tibia at Billancourt (Seine), near some animal remains of the quaternary period. There was a difference of opinion as to whether it was of the same period as the other fragments or not, but since on analysis the proportion of fluorine in the animal bones was found to vary from 0·469 to 0·578 as compared with 0·066 in the human tibia, the more recent origin of the latter was regarded as established.—*Comptes Rendus.*

PORTSMOUTH AND ITS DOCKYARD.

By Commander C. N. ROBINSON, R.N.

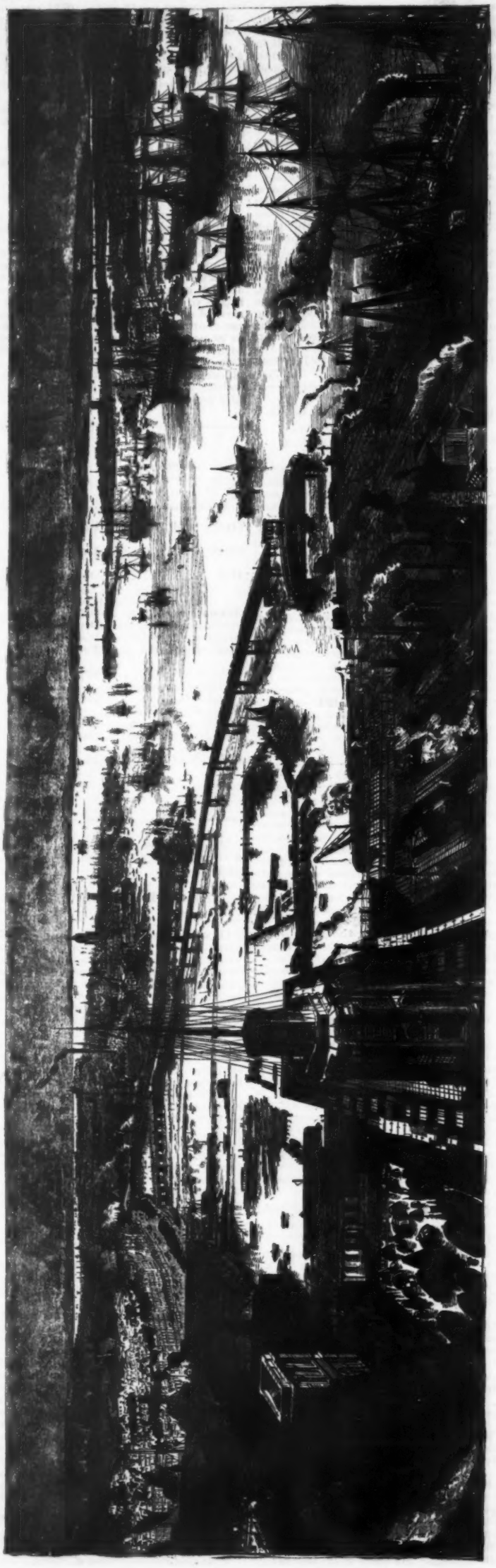
PORTSMOUTH and the navy are inseparably associated in the minds of all Englishmen. It could not well be otherwise, since the one is the headquarters of the other. The great seaport owes its importance to its connection with the sea service which has made our empire what it is. Its annals are bound up with those of the great men whose achievements are as household words in our land; its streets, its churches, its hotels—not to mention the dockyard at its gates—even its very stones are reminiscent of the navy and naval people far back into the dim past of our history. It would be curious if Portsmouth were not among the most interesting and noteworthy of English towns.

Portsmouth of to-day is a congeries of villages grown into towns. Sunny Southsea, the suburban home of the wives and families of naval officers and dockyard officials, has become a fashionable watering place, until scarcely a vestige remains of the earlier village. Landport, with its long rows of cottages, in which the dockyard men formed a colony by themselves, has almost grown out of recognition, with its magnificent city hall and other palatial buildings. Here the theater immortalized by Dickens now has its rival, and around the railway has grown up a populous city. Last, but not least, Portsea, "a mere excrescence of the dockyard," as one writer calls it, if it has not increased in size, has certainly put on a brighter and more prosperous appearance. These offshoots encircling the old town gradually dwarfed their parent until, at last, when the ancient fortifications, so feelingly described in "Celia's Arbor," were leveled and laid out in gardens and recreation grounds, the old became merged in the new, and the parent was lost in the embraces of her children.

But Portsmouth proper must always retain its individuality in one respect—neither Southsea, with its villas, nor Landport, with its halls, can take from it the characteristic features which are its glory and its renown. It is with Portsmouth that we connect the first appearance of a regular naval establishment, when, by order of that eminent prelate who was, as it were, secretary of the navy to King John, the docks for the war galleys were inclosed in a fortification, and penthouses were built for their tackle. Portsmouth and its yard was a very small affair in those days, when the navy of England consisted of about fifty galleys, and these were lent out to the various seaports for local defense. However, when it was necessary to call together the fleet for some national undertaking, this port was usually chosen as the *rendezvous* to which they were summoned. The quaint old parish church of St. Thomas, which dates from about this period, must have looked down upon strange and memorable scenes in its time; and its peal of bells, which are said to have been stolen from Dover by some practical-joke loving admiral, must have rung out many a time in jollity and gladness as greeting to a preserver of the realm on his home coming. Under its aisles rest the ashes of many departed naval worthies, and its records are filled with the births, marriages, and deaths of gallant seamen. Close by it the Duke of Buckingham was stabbed by Felton in 1628. According to the story, Felton was a lieutenant in the navy, and in this way he avenged himself for having been badly treated in the matter of promotion. If naval lieutenants in the present day were to follow his method of settling their claims in this respect, it would not be long before seats at the Admiralty board were at a discount, and sea lords as difficult to discover as the philosopher's stone. The hotels of Portsmouth—who has not heard their histories? The George, the Fountain, and the Blue Posts. The George was originally a thatched public house, called the Waggon and Lamb, and, as such, has associations back to the time of the Tudors.

It was not enlarged to anything like its present size until 1814, but the room in which Nelson slept before he went to sea in 1803, and that in which he breakfasted on the morning of September 14, 1805, are still shown. Before the fortifications were pulled down, the point was separated from the town by gates; Rowlandson, who came down here in 1782 to have a look at the wreck of the Royal George, has left us characteristic sketches of it as it appeared in those days. The principal hostelries outside were the Star and Garter, used by the superior officers, and the Blue Posts, a coaching house, frequented by midshipmen and made familiar to every British boy by Marryat. For more than two centuries this house was used by naval men until it was burned in 1870. At the time of the mutiny at Spithead, in 1797, when the bluejackets wished to land at Portsmouth that they might bury some of their messmates, the governor put the place in a posture of defense, placing field pieces at the Point Gates to flank the Sally Port—where Peter Simple afterward had a memorable encounter—and where at this time a bloody fight was expected. But the mayor of Portsmouth, like many a mayor that has followed him, was equal to the occasion, and effected a compromise by which the men brought their shipmates' bodies ashore at the Common or public Hard, and so took them to Kingston churchyard.

Mention of the Common Hard takes us out of Portsmouth to Portsea and to the dockyard, and though we might well linger here awhile at the "nut," exigences of space require that we hurry on and get within the gates. Though not, perhaps, the first established—since Deptford and Woolwich claim priority—Portsmouth dockyard has, since its foundation in 1512, been the principal national institution of the kind. On its slips some of the finest ships have been built, and from its wharves the noblest wooden walls and ironclads of England have taken their departure to establish or maintain our naval supremacy, to found



BIRD'S EYE VIEW OF PORTSMOUTH HARBOR—DRAWN BY H. W. BREWER, FOR THE *London Graphic.*

our world-wide empire or preserve its integrity. There are few monarchs who have sat on England's throne who have not paid Portsmouth dockyard a visit, and many foreign potentates have seen and marveled at its numerous docks, sheds, factories, and basins busy with naval preparations unequaled on the face of the globe.

Let us climb the semaphore tower over the rigging house, and look around at the view, of which we give an illustration. Below us, as we glance across the harbor, is a big ship at the railway jetty, possibly an Indian trooper but recently returned from Bombay with sunburned soldiers; the swinging gate which carries the train of carriages over the jetty in front of the Hard was lately carried away and smashed to smithereens by one of these huge ships, which cannoned against it in a fog, but here it is in good working order, and swung open to allow of the passage of a vessel. A little further out in the stream are three venerable men-of-war, wooden sailing liners of the old type, which, with but trifling alteration, carried Blake and Shovell, Anson and Hawke, Howe and Jervis, Collingwood and Nelson to victory. The biggest, on the right, is the Duke of Wellington, recently the flagship of the naval commander-in-chief, but now removed to make way for a sea-going armored cruiser, the Nelson. The Duke of Wellington was Napier's flagship in the Baltic during the Russian war, and mounted 130 guns, the biggest of which was as but a popgun to the 110-ton monsters of to-day.

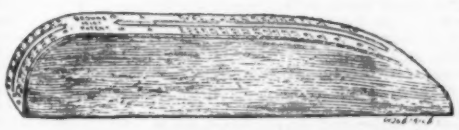
A little further on is that grand old relic, familiar to every Briton, the battered and venerated Victory, the scene of Nelson's last triumph and his death. The glorious old ship is now in her hundred and twenty-seventh year, and as a national memorial may last another hundred years at least. The third ship is the St. Vincent, the training ship for naval sailor boys, and near her lies the natty little training brig in which the lads are exercised and gain their sea legs. Besides these there are many more small craft and not a few old harbor hulks, all of which have seen good service in their previous existence, but are now doomed, in somber black or ugly dockyard drab, to end their days in humble and peaceful usefulness. Behind the three splendid specimens of old naval architecture is Gosport, with the victualing yard and its bakeries and storehouses, and Haslar Hospital, a fine pile of buildings, with its tower showing above the creek, where yachts and gunboats lie hauled up for the winter. For background to the scene we have the green slopes of the Isle of Wight and Osborne overlooking the waters of the Solent, and the historic anchorage of Spithead, in which so many stirring spectacles have been witnessed, from the memorable occasion when the French and English fleets fought there in 1545, and the Mary Rose foundered in the battle, down to the not less memorable visit of another French fleet last year as honored guests of the nation. A little nearer, on the left, we see the entrance to the harbor, flanked on one side by the Point and on the other by the Fort, from whence, in the old war, a chain was hauled across the mouth of the port at night to prevent raids upon the vessels lying in security within.

But we might go on writing about Portsmouth and its yards for many columns more than can be spared here. As may be expected, it is a very different place now to what it was even when the last wooden ships were being constructed there. Steam and steel and electricity, which have effected such marvelous changes in the material of modern navies, have left their mark in Portsmouth dockyard also. The little slip of land which Henry VIII. added to the yard has increased until its area is now upward of 115 acres, while more land is yet to be reclaimed and added to it. Whereas, in 1650, there were not more than one hundred shipwrights employed in the yard, and these chiefly Italians, there are now from 5,000 to 6,000 workmen, drawing annually nearly a third of a million in wages.

When the improvements in progress are completed, this vast establishment will contain five building slips and fifteen dry docks, besides the long locks between the basins, which can be used as docks if necessary. But these and more are needed if the British empire is not to fall to pieces on the shock of war. The navy is the 'life's blood of her national integrity, and this arsenal its heart; is it not essential, then, to keep it in healthy condition and vigorous working order?—*The Graphic.*

GRADIENT INDICATOR.

THIS is a self-adjusting gradient indicator for surveying, mining, and sanitary work, an illustration of which is given herewith. This instrument combines, in a convenient form, a set of spirit tubes, two of these being curved in such a manner that on application to



any given surface the air bubble will become stationary opposite the point indicating the gradient of the surface to which it is applied. The long tube is used for all indications from 1 in 2 to 1 in 200 from horizontal positions, and has a point showing level, the short tube being used for all vertical work, indicating by the position of the bubble gradients from 15 degrees to plumb; thus, supposing the fall of surface to be 1 in 30, the bubble will float midway to the point marked 30 on the plate inclosing the long tube; or, if a batter of, say, 45 degrees is being tested, it will be found that the bubble is floating midway to a point marked 45° on the indicating plate inclosing the shortened tube upon the application of the instrument to the surface. It will thus be seen that the instrument indicates at a glance and without setting the inclination of a surface to which it is applied, and there are no parts to adjust or become worn.—*Industries.*

THE Smithsonian Institution has received from China a pair of stockings manufactured from human hair. They are worn by fishermen over cotton stockings (being too rough for the naked skin), and under straw shoes, as a protection against moisture.

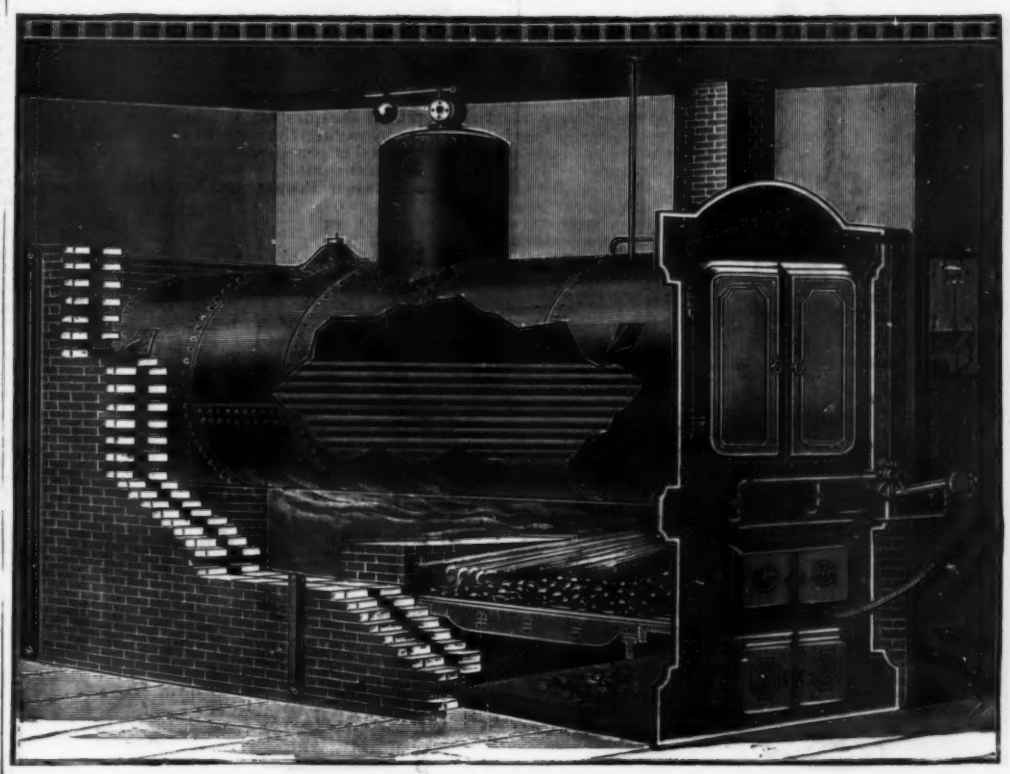
SARGENT'S SMOKE PREVENTING FURNACE.

THE great desirability of some simple form of apparatus by means of which the smoke of boiler furnaces will be effectively consumed has long been conceded, and it is especially needed in all manufacturing centers where soft coal is used. It does not require many establishments, whose furnaces are fired with bituminous coal in the ordinary way, to pollute the atmosphere and deface the buildings of a pretty extensive area, with the large amount of smoke discharged from the chimneys, added to which is the waste of fuel accompanying this discharge, of which every engineer is conscious as he notices the volumes of black carbon rolling skyward. To obviate this difficulty is the design of the smoke-preventing apparatus shown as applied to a furnace in operation, in the accompanying illustration, and which has been patented by James Sargent, Esq., of Rochester, N. Y.

The apparatus works automatically, being controlled by a time movement. A pipe leads from the top of the boiler to the inside of the fire box at its front end, where, upon opening a valve, dry steam is discharged in powerful jets upon and over the surface of the coals, forcing the smoke, at the instant of forming, into the live coals, where it is consumed. The valve for starting the steam discharge is operated automatically with the opening of the furnace door to feed the fire, the swinging open of the door also actuating a lever connected with a time movement, whereby an air door is raised, the discharge of steam continuing, and the air door remaining open until the combustion of the newly supplied coal has been well started; and, finally, when the hydrocarbons are all distilled off and consumed, the steam jet and air door are both shut automatically.

fering with its regular and continuous use. It is durable, and when once in place, requires no more attention than any other fitting to the boiler or furnace. It is moderate in first cost, and its use in the majority of cases will lead to an economy of fuel more than sufficient to pay for it in a short time.

As shown in the sectional elevation of steam boiler and furnace with the apparatus attached and in full operation, the dry steam is conveyed from the top of the boiler and injected into the fire box through two properly arranged jets with a special form of tip, two jets being thought, in ordinary cases, to give the best results, although in one class of special cases a single jet will be sufficient, while in another, three or more will be used. The special tip is so constructed as to distribute a thin sheet of steam moving with high velocity throughout the entire upper portion of the fire box. As shown in the cut, the steam jets enter the fire box above the air inlet, whence it results that the current of air is carried into the furnace in a solid column, which for a considerable portion of its journey from the boiler front to the bridge wall is mostly confined between the sheet of steam above it and the live fire beneath. The specific heat of air is so slight that the entering air current quickly reaches the temperature of the incandescent coal beneath, so that by the time the current reaches the vicinity of the bridge wall it is in proper condition to produce, in conjunction with the steam, a complete combustion in the manner described. Moreover, during the latter part of the journey from front to rear in the fire box, the expansion of the air current has caused it to ascend and mingle with the steam jet, thereby producing, through the medium of a blowpipe action, the necessary conditions for perfect combustion. In its practical application, thus far, a decided saving of fuel has been proved to be effected



SARGENT'S SMOKE PREVENTING FURNACE.

The time movement is adjustable, so that this period can be made longer or shorter, as may be desired.

That the combustion is actually improved by this smoke consumption is proved by the fact that the steam gauge shows increased pressure during the time the air door is kept open and while the fresh coal is being started, according to this method. The boiler tubes, also, do not require the frequent cleaning necessary under the old plan, being entirely free from the usual accumulation of gummy soot, but having, instead, only a slight deposit of a dry, ashy substance.

This smoke consumer has been for some time in successful operation in several large establishments in Rochester, N. Y., notably in the Kimball tobacco factory, and the result of two days' trial at the latter place, one day with and the other day without the use of the device, is given in the following certificate:

June 22, 1892.—With smoke preventer:
2,433 lb. coal consumed in seven hours and twenty minutes.
Weight of water evaporated, 21,600 lb.; 8·88 lb. of water to 1 lb. of coal.
Steam pressure, 66 lb.
Comparatively very little smoke at any time.

June 23, 1892.—Without smoke preventer:
2,433 lb. coal consumed in six hours and forty minutes.
Weight of water evaporated, 18,823 lb.; 7·73 lb. of water to 1 lb. of coal.
Steam pressure, 64 lb.
At each time of firing, and from five to eight minutes afterward, a heavy volume of smoke issued from the chimney. W. J. DUNN, *Engineer.*

It will be readily seen that the application of the time movement, for the control of the steam discharge and the operation of the air doors, according to the draught of the furnace, the kind of fuel, and the manner of feeding, gives the engineer the means of regulating the working of the apparatus in such manner as to almost entirely prevent the escape of smoke into the air, practically irrespective of the condition of the weather. The apparatus may be attached in a few hours to any steam setting, without in any way interfering with its regular and continuous use. It is durable, and when once in place, requires no more attention than any other fitting to the boiler or furnace. It is moderate in first cost, and its use in the majority of cases will lead to an economy of fuel more than sufficient to pay for it in a short time.

As shown in the sectional elevation of steam boiler and furnace with the apparatus attached and in full operation, the dry steam is conveyed from the top of the boiler and injected into the fire box through two properly arranged jets with a special form of tip, two jets being thought, in ordinary cases, to give the best results, although in one class of special cases a single jet will be sufficient, while in another, three or more will be used. The special tip is so constructed as to distribute a thin sheet of steam moving with high velocity throughout the entire upper portion of the fire box. As shown in the cut, the steam jets enter the fire box above the air inlet, whence it results that the current of air is carried into the furnace in a solid column, which for a considerable portion of its journey from the boiler front to the bridge wall is mostly confined between the sheet of steam above it and the live fire beneath. The specific heat of air is so slight that the entering air current quickly reaches the temperature of the incandescent coal beneath, so that by the time the current reaches the vicinity of the bridge wall it is in proper condition to produce, in conjunction with the steam, a complete combustion in the manner described. Moreover, during the latter part of the journey from front to rear in the fire box, the expansion of the air current has caused it to ascend and mingle with the steam jet, thereby producing, through the medium of a blowpipe action, the necessary conditions for perfect combustion. In its practical application, thus far, a decided saving of fuel has been proved to be effected by this improvement, as well as the almost complete abatement of the smoke nuisance.

JAMES SARGENT.

THE name of the inventor of the smoke consumer above described has been for a long time a familiar one with all who take pride in the triumphs of American invention for which this age is noted. From 1852, when he first engaged in a manufacturing business on his own account, until the present time, his numerous inventions have constituted a conspicuous feature in the Patent Office records, but probably the most widely known of them all is the time lock. As a traveler for the Yale & Greenleaf Lock Co., Mr. Sargent early became a noted "lock-pick," and, finally, in 1865, commenced the manufacture of a lock invented and patented by himself. As a prominent feature in this invention, a powerful magnet was introduced, which held other parts sufficiently under its control to prevent the use of a micrometer in measuring motion or determining relative positions of the unlocking devices. This was, and is, known as the Sargent magnetic bank lock. A mechanical, automatic device was later introduced for the same purpose, which dispensed with the magnet, and is the prevailing style at this time, under the name of the Sargent automatic bank lock. Numerous experiments, improvements, and changes were constantly made, until, in 1873, Mr. Sargent perfected his first model of a time lock, which was put in practical use by a bank at Morrison, Ill., in May, 1874, and is still in service. This style of lock has proved a wonderful success, and it is said that the original forms were so complete and comprehensive that no radical change has been found necessary in the lock up to the present time. Mr. Sargent, though still retaining his interest in the lock business, is also engaged in a diversity of other enterprises.

THE "FLUOMETER."

OF late years the use of pumps for raising liquids by the direct action of steam has been greatly extended, and manufacturers, contractors, colliery proprietors, and others have recognized in this class of pump a handy and inexpensive machine. These pumps are all based upon the principle embodied in Savery's "fire engine," as used at the end of the seventeenth century. The points in favor of this form of pump are the absence of pistons, rams, and other working parts requiring lubrication, packing, and skilled attention.

The accompanying illustrations represent the "fluometer," a steam vacuum pump, which is being introduced by Messrs. Joseph Evans & Sons, of Wolverhampton. From the description it will be seen that this, the latest development in this sort of pumps, possesses several novel features. Referring to our illustration, Fig. 2 is a sectional elevation of the pump showing the general construction. A is the working chamber, B is the suction valve for inlet of the water to the working chamber, and C is the delivery valve. There is no steam valve or steam-controlling device whatever, the pipe being screwed into the steam inlet flange, and allows the free ingress of steam to the working chamber during the whole time the pump is at work, being regulated in amount only by the ordinary wheel valve fixed in the steam pipe. E is an auxiliary chamber acting as an air vessel, which, during the discharging period, receives a certain quantity of the water or other liquid being pumped to afterward serve as an injection during the time that the vacuum is being formed. F is also an injection device communicating with the delivery column, which, in some instances, is used in lieu of, or in addition to, the injection chamber, E. The shifting valve, G, is for the purpose of admitting a small quantity of air at the time there is a vacuum in the working chamber, in order to form a cushioning arrangement to absorb any unspent energy in the incoming water. This valve is designed in a substantial form, and is provided with screw plugs for access to the valve and for cleaning out purposes. The valve stem is uppermost, and has a screw thread cut upon it on which the milled nut for adjusting the lift works. A small brass spring serves to keep the valve against its face, and also insures its not opening until the vacuum created in the working chamber is sufficient to lift the water the given height of suction. A gun metal thimble, cut away on opposite sides, covers the valve stem to prevent injury, and also serves as a guide to the squared end of the valve stem. A feature claimed for this valve is that leakage does not produce corrosion of the screw or adjustment nut. The delivery valve chamber, H, is provided with a dip pipe which makes it an efficient air vessel. The doors for access to the suction and delivery valves are constructed each with two strong hinged bolts, and are thus quickly taken off. A strong lug is cast on the working chamber of the pump to which a shackle may be fixed for slinging the pump down a shaft or excavation, or for staying it to a bulkhead, and convenient feet are provided to enable it to be fixed permanently to small foundations.

FIG. 1.—GENERAL VIEW OF APPARATUS.

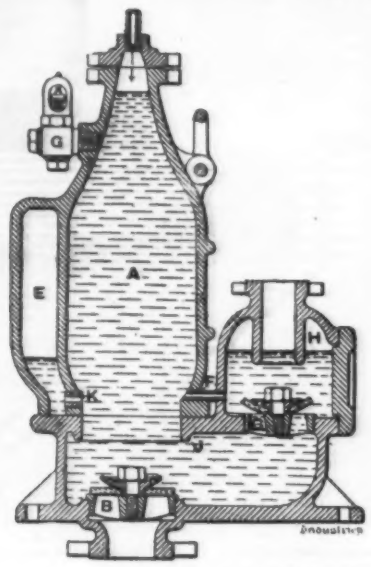


FIG. 2.—SECTIONAL ELEVATION.

The action of the pump is as follows: The steam flowing in through the steam pipe depresses the water in the working chamber, A, driving it through the delivery valve, C, and up the delivery pipe. This is done without disturbance of the level; consequently, the top layer of water in immediate contact with the steam becomes heated, and, by reason of its reduced density, remains at the top, thus preventing further condensation. A portion of the water passes into the injection chamber, E, through the inlet, K, where it remains under a pressure equal to that in the working chamber. In this manner the water level falls until it arrives at the offset, J, when a violent disturbance takes place, and reduction of pressure is, in consequence, brought about. The injection water now rushes in from the chamber, E, and completes the vacuum, causing a fresh supply of water to enter from the suction pipe. The inrush of the suction water is so violent that it is necessary to restrict the passageway into the pump at the lower extremity of the working chamber and to take in a small amount of air through the snifting valve, G. This air serves the double purpose of cushioning the flow of the water, and, subsequently, by mingling with the steam, prevents condensation of the latter by reason of its low conductivity. The working chamber, A, being now filled again, the action is repeated as long as the steam valve remains open and there is water to pump. The flow of steam is practically constant, as the vacuum period is extremely short; therefore, very little condensation of steam takes place. From the above description it will be seen that the "fluometer" requires no steam-controlling valve whatever, beyond the ordinary stop valve.

The "fluometer" may be set to work either by filling the pump and suction pipes with water through the priming plug provided for the purpose or in the following manner: Assuming that the pump and suction pipe are empty of water, the steam is turned on and rushes into the pump, expelling the air. After the air has been expelled the steam is shut off and allowed to remain off a few seconds while condensation takes place, creating a vacuum in the working chamber and causing the water to flow up the suction pipe. This operation is repeated two or three times, when the pump will be found to be filled with water, and the steam may be left on after the attendant has regulated the amount to be admitted to attain the best results. —*Industries.*

HIGHER SPEED OF RAILWAY TRAINS.*

WE are told that Stephenson nearly defeated his object, when advocating the first steam railway, by asserting that trains could be moved at a rate of 12 miles per hour. This was soon accomplished, and then began the cry for higher speed. To-day, with trains running regularly at 40 to 50 miles per hour, the cry still continues, and increases in a direct ratio with the increase of speed. It is the duty of the railway manager to comply with all reasonable demands of the public. The public demands higher speed. Is it practicable to comply? If not, then the demand is unreasonable.

In my opinion the question as to railway speed may be answered by saying that (within a certain limit, of course) any speed is practicable which the public will pay for. When the public is willing to pay for a three hours' ride between Boston and New York, it can be accommodated with as good a degree of safety as it now enjoys while making the journey in six hours. That locomotives can be built capable of attaining a speed of 80 or 90 miles an hour, with light loads, is beyond question; and we can conceive of a railway so constructed as to admit of such a speed with reasonable safety. But that such a road can be built and operated so as to render a fair return upon the capital invested, I believe is a question not worthy of serious consideration at the present time, although it may not be out of place to mention a few of the reasons which, to my mind, render it practically impossible to attain such a speed, for a long time to come at least.

One of the most important things, perhaps the most important, to be considered when we start a train is our ability to stop it. Mr. Geo. Westinghouse, Jr. (I suppose the highest living authority), tells us that with a perfect brake acting upon all the wheels of an express train running at a speed of 90 miles an hour, at the end of ten seconds after the application of the brake the train would still be moving at 60 miles an hour and would have traveled 1,130 ft. It would be brought to a stand in about 1,200 ft. more, or 2,330 ft. in all. But under the best actual conditions now existing, at the end of 16 seconds the train would be moving at 61 miles an hour and would have to travel about 1,800 ft. further to come to a stop.

With this fact staring us in the face it seems a waste of time to talk of running trains at such speed on our present tracks and in connection with the ordinary passenger and freight traffic. The question then is: Is it possible to put our present railways in condition to meet the necessary requirements, and if it is possible, is it a practical proposition? To the first question I would answer, yes; to the latter, no. I say no because there is no reasonable probability that it would result in a sufficiently increased revenue to warrant the outlay. The necessary changes in roadway and track would amount, practically, to the relocating and rebuilding of our roads.

Mr. Theodore Voorhees, an authority on high speeds, tells us that an ideal railway would be perfectly level and straight, with a roadbed and track heavy, substantial, and well drained, with no grade crossings or openings to invite trespassers; with bridges whose floors should be as solid as the roadbed itself, and with stations so planned that no passenger could ever set foot on the track. I would add to this that these tracks must be devoted exclusively to high speed trains and must be located at a sufficient distance from all other tracks and from each other to avoid the danger, ever present with us now, of an accident on one track causing a tenfold worse one on another. Add to this a perfect system of signals, constructed with due regard to the capacity of the human eye, and operated in connection with a mechanical device automatic and positive in its action, which will, in the event of a failure on the part of an engineman from any cause to obey the signal, bring a train to a stand before reaching the danger point. Then with equipment constructed of the best material and under the most rigid inspection, we may travel on such a track at 80, 90, or even 100 miles an hour with comparative safety. All of these requirements can be met, but only with unlimited capital; and I fear that none of us here will ever see the ideal realized.

Leaving, then, the question of extraordinary speeds to theorists and the future, is it practicable to make any increase in the average express train speed on what may be termed our first class railways? Assuming 40 miles an hour as the present general average and 45 miles an hour as a special average, can we increase these speeds by say 25 per cent., making them 50 and 60 miles an hour, and to what extent does it involve the ordinary or local traffic? What system and appliances are necessary to accomplish it? Is our roadway and track safe for such increase, and, if not, can it be made so at a reasonable outlay?

Taking these questions in reverse order, roadway and track are the first essential to high speed. I do not think it necessary to devote much time to their consideration in connection with the subject now before us, as the improvements now being made on most of our trunk lines are fast bringing them into a condition to render them, so far as the track is concerned, more safe for a speed of 60 miles an hour than they formerly were for 30 miles an hour; in fact, many roads have already reached that condition. Solid masonry, iron and steel have taken the place of the loose field stone and wood in bridges and culverts; crushed rock and gravel, that of loam and other inferior material as ballast; steel rails have been substituted for iron; the number of cross ties has been largely increased; the weight and strength of the rail and of all parts of the track proper have been nearly or quite doubled; dangerous curves have been straightened; grade crossings are being abolished or more securely guarded; safety switches are almost universal, and the facing point is rapidly disappearing. With these and other improvements made and being made, we may safely answer this question in the affirmative.

Taking next the question of appliances; the motive power would seem to be first in order. Few outside of the men who have brought the modern locomotive to its present development realize the wonders of the machine or the enormous power developed daily. What future development is needed in the locomotive to increase the average train speed by 25 per cent., I will leave for these men to discuss, and answer, fully believing that it can and will be accomplished whenever demanded by the financial and operating departments.

I want, however, to bring up a question which has long been in my mind and is brought out forcibly by a series of tests and records made on one of the "Shore Line" trains between Boston and Providence, and which is a fair sample of express train service in New England. This train is scheduled to make the run of 44 miles in 65 minutes, including two stops.

Making the liberal allowance of five minutes for the two stops, it will be seen that it is only necessary for this train to make an average of 44 miles an hour: and yet it was found that on seven of the eight trips covered the speed during some parts of the run exceeded 70 miles an hour, and on one occasion reached 77¼ miles an hour. There is nothing exceptional about this train; equal fluctuations will be found to be the rule, particularly in New England.

From this it appears that with a locomotive capable of maintaining the average speed on the up grades existing on nearly all roads, we may increase our speed to 50 or 60 miles an hour without any actual increase in the rate which we are daily reaching, and owing to the fact that a train can be brought to a stop within a much less distance on an up grade than on a descending or level track, with no increased risk. My question then is: Do we not want more power in the locomotive rather than more speed, and is it not possible to bring this about? Otherwise, does not an increase of 25 per cent. in the average mean a maximum rate beyond the safety limit? In other words, can we not best increase the speed by making it more uniform? Next in order and importance, after getting our locomotive to give us the speed, comes the brake to control it. Notwithstanding the wonders already achieved, much remains to be done in this line; experiments have demonstrated that at 60 miles an hour the braking force should be double that usually employed. We must have that force and it must be applied to every wheel in the train, not excepting the locomotive trucks. One of our Boston roads has recently applied the truck brake to some of its locomotives with such good results that a large number have been ordered, its efficiency and value being demonstrated beyond question.

We must have an automatic device to regulate the brake shoe pressure according to the speed, so as to avoid "skidding" of the wheels and consequent loss of efficiency, and all parts of the brake must be strengthened to withstand the increased force to be applied. For emergency stops we must have a sand jet operated simultaneously with the air brake. Devices to accomplish this are brought out for attachment to the locomotive; they should be perfected and attached to the cars as well.

Our next problem is to remove as far as possible every known danger from the path of our train, and guard against such as cannot be removed by the best

* A paper by C. A. McAlpine, Supt. Northern Division Old Colony R.R., read before the New England Railroad Club.—*Engineering News.*

known appliances. At way stations where passengers must cross the main tracks, overhead or underground passages should be provided, and measures adopted to compel their use. Facing switches should be removed except where they are an absolute necessity, and whenever allowed to exist they should be guarded by an interlocked or electric signal, or both. All sidings should have derailing switches at the fouling point, connected with the main track switch. Drawbridges, junctions, and all other points where the tracks are of necessity frequently broken and obstructed, should have a system of interlocking switches and signals, and the entire line should be covered by some system of block signals, a purpose to which the electric track circuit seems best adapted as covering the widest range of possible dangers, and being the least dependent on human agency for the faithful performance of its duty; in fact, I look for improvements in the application of electricity that will make it the railway watchman of the future.

All fixed signals should be uniform in form and meaning, and care should be taken not to multiply them needlessly, making it a study to remove or group danger points, whenever possible, rather than add to the number of signals. For night signals, electricity has proved itself far better and more reliable than the oil lamp, and should be used wherever available.

Operating in connection with every fixed signal which is to be used for a stop signal, we should have a device which will apply the brakes and bring our train to a stop whenever the signal indicates danger, independent of any action on the part of the engineman. Appliances of this kind are now being put to the test of actual service, and that they will prove a valuable addition to our safety appliances, either in their present or an improved form, I have no doubt.

It would now seem that with these improvements and additional safeguards our train might go on its way in safety; but we have yet to meet and overcome one of our worst dangers, and one that has never received the consideration that it merits. This danger lies in the freight train running, not on our track, but upon the track seven feet or less away. Be our roadway and tracks as substantial as the hills, our drawbridges, junctions, stations, sidings and crossings ever so well guarded, our block system of signals ever so complete, our locomotive and cars perfect in their construction and equipment, yet in the face of an obstruction thrown on our track by a mishap to the freight, it all goes for naught.

Whenever a fast passenger train meets and safely passes a freight train running on the opposite track, and this happens many times a day on most roads, it narrowly escapes disaster. Many frightful accidents have happened from this cause, and their number will increase with the increase of passenger and freight traffic, and the speed of trains, unless a remedy is applied; the remedy lies in one direction, and in one only; we must prevent the mishap to the freight train.

To do this we must raise the standard of our freight equipment; quality rather than price must govern the selection of material for its construction; all old or weak cars must be discarded, and the freight car made to carry its load with as much safety as does the passenger coach. The old fashioned door, which easily slips from its fastenings, and often followed by a part of the contents of the car, falls to the opposite track or against the side of a passing train, has performed its mission, and must go, the sooner the better.

Breaking apart of the train, that fruitful source of trouble, and perhaps directly and indirectly responsible for more accidents and delays than any other one cause, must and can be stopped or reduced to a minimum. This may seem a bold statement, and I am aware that the coupler problem has not yet reached a point to warrant it; but I have yet to learn any good reason, financial or otherwise, why, pending the solving of the problem, freight cars should not be equipped with safety chains. Their application is simple and comparatively inexpensive, and I firmly believe that if applied to all cars they would more than repay their cost the first year in the saving of accidents and delays. If any gentleman present has ever tugged a draught chain through three feet of snow, from the caboose to the twentieth car of the train, he will agree with me.

Stringent regulations must be adopted and enforced to prevent overloading and improper loading of cars, and better means provided for the securing of such freight as must be carried on open cars; in fact, wherever passenger and freight traffic are both conducted over the same or adjacent tracks, equal care for their safety must be exercised.

These, to my mind, are the principal physical and mechanical requirements necessary to higher speed. But with all these requirements met, we are still dependent for success and safety on the loyalty of the men engaged in the service. I use the term loyalty because it expresses all that men should be, and it should apply to all ranks from general manager down. He who is loyal to the company he serves, and to himself, will do his best under any and all circumstances, and will have the interests of his employers at heart always.

More care should be exercised in the selection of men than has been hitherto. Applications for positions of responsibility on our roads, or from which promotions to positions of responsibility are made, should be in writing in a regular form, accompanied by references; such applications to be referred to a standing committee, composed of experienced officials from different departments, with a representative employe from the department to which the application was made. The applicant's general character could then be investigated and, if found satisfactory, notice sent him to appear for examination, regular dates being fixed for the purpose. The committee, if satisfied of the man's fitness for the service, would forward a certificate to that effect to the proper head of the department, who would enter the application, to be taken up in regular order as vacancies occurred. Examination should be made from time to time of employes in line of promotion.

Should such a plan be adopted, its advantages would be felt in every direction; the intemperate and vicious would be kept out of the service; those well meaning, but lacking in natural fitness, would be saved from ultimate failure and disappointment, which, by the way, is often postponed at a frightful cost of life and property; accidents would be reduced to a minimum; strikes would be unheard of; with such material once enlisted and fairly treated, the tramp railroad man, the bane of the service, would disappear; and not the least of all, a fearful load of individual responsibility would be lifted from individual shoulders.

What effect an increase of 25 per cent. in the speed of our express trains; will have on the local traffic is an important consideration, and can only be determined by the volume and character of the traffic. In many cases it will mean an equal increase in the speed of local passenger trains at least; otherwise local trains would have to side track and wait the passage of express trains; trains would soon become bunched, and a general demoralization of the train service would result.

The speed of these trains can be increased, but the cost of such increase must be considered as vital to the question at issue, and in this calculation the rapid rate at which the train resistance increases with increased speed will cut an important figure. I do not know that the exact ratio of this increase has ever been determined, but the diagram given us by Mr. Forney is probably approximately correct. From this it appears that on a level track, at 40 miles an hour, the resistance is about double that at 25 miles an hour, and at 60 miles an hour it has again nearly doubled, being respectively 7, 13, and 25 lb. per ton.

(Recent experiments seem to show that resistance at high speeds is not as great as has been generally supposed. See *Eng. News*, June 9, 1892.—Ed.)

What is a reasonable speed must be determined by each railway manager for himself, and not by the public. The average traveler whirled along at 40 or 50 miles an hour has little idea of the conditions necessary to insure his safety, and when an accident does happen expressions of surprise are general; but the thinking railway man, although he may not express his feelings, is surprised that they happen so seldom. It is true that numerous American roads are safely running one or more daily trains at an exceptionally high speed; but these trains are operated under provisions which cannot be accorded to the general express traffic; and the wisdom of encouraging a public demand which we are not prepared to meet is questioned by many able railway managers.

The steady increase of traffic calls for improvement in system and appliances to enable us to maintain our present speed with safety. We should meet these requirements before making any attempt at an increase. I am alive to the fact that speed in all things is the order of the day, and I would not be counted as in the rear of the procession, but I do not want to see the dangerous experiment of higher speed without a proportionate advance in system and safety appliances.

FIG. 1.—PHOTOGRAPHIC MIRAGE—SHADOW OF THE OPERATOR PROJECTED UPON FOG.

THE PHOTOGRAPHIC MIRAGE.

WE are going to present to our readers a singular photographic phenomenon which, to our knowledge, has never been made known up to the present, and which we have had occasion to study for several years past. The following is the first example of a fact of this kind that has been presented to us as a phenomenon of *photographic mirage*. We owe the communication of it to a skillful operator, Mr. Paul Roy, professor at the Lyceum of Algiers. Prof. Roy sent us the following letter under date of May 16, 1889:

"I have the honor to address to you a communication concerning a case of a very singular mirage, and which perhaps you will find of sufficient interest to make known to your readers. In a field situated at El Biar, near Algiers, at 250 meters altitude, during a fog that was not very intense near the ground, at 8 o'clock in the morning, I had exposed my young son, one second, with an objective of full aperture. Such time of exposure would have been much exaggerated in clear weather, for usually one-twentieth of a second suffices. My son was seated in full light, and the background was formed of a very thick curtain of trees and bushes. A perceptible current of air made the fog pass along the trees like a river. After developing the negative, I was extremely surprised to see my own portrait, in the attitude that I stood in when I opened the objective, delineated behind that of my son. I send you two prints of it, one of which is somewhat weak in order to render the silhouette more sensible. My image is necessarily vague, because I had no reason to preserve immobility. I have endeavored, at various times, to obtain other negatives reproducing the same phenomenon, but always without success."

Fig. 1 reproduces in fac-simile one of the photographs sent us by our correspondent. The image of the operator is very plainly visible, and resembles those photographic specters obtained of old by a jester by means of two successive impressions. Here there is but one. There is no deception, and it seems indeed that it is a question of the image of the operator reflected upon the fog. We know that shadows do sometimes form upon fog, and we have had an opportunity of observing phenomena of this kind. It may be here that the shadow of the operator projected upon the fog was not visible to the naked eye, and yet that it existed sufficiently to make an impression upon the sensitized plate.

We had put aside the curious document that we have just made known, having been content to show it to several distinguished operators, to whom it appeared to offer the greatest interest. We have very recently received a new document from one of our readers which seems to us to present much analogy with the one just spoken of. It concerns a photograph taken by Mr. Chas. Le Corbeiller, member of the Photo Club, of Paris. It represents the statue of David upon Michael Angelo Place, at Florence. The shadow of the statue and its pedestal is projected upon the clouds after the manner of the specter of Ulloa (Fig. 2). The following is the note communicated to us on the subject by Mr. Le Corbeiller:

"This photograph was taken in the latter part of April, 1877, one afternoon, after a very heavy rain storm. The sky was cloudy. The apparatus used was constructed by Gilles Brothers, the objective was by Derogy, and the plates were those of Van Monckhoven. The developing was done with ferrous oxalate. The reflection of the statue upon the clouds was invisible to the operator. The exposure was three seconds."

It will be remarked that there is a great analogy in the state of the weather at the time of obtaining this photograph and that which we made known in the first place. It may be, again, that it is a question of a projected shadow invisible to the naked eye and yet sensitive enough to make an impression upon the gelatino-bromide of silver plate.

There may be here a new way open to the observation of photographs. We present it as yet, however, only with prudent reserves while awaiting new exper-

FIG. 2.—STATUE OF DAVID AT FLORENCE PROJECTED UPON THE CLOUDS.

iments to pronounce upon it with entire certainty. We do not ignore the fact that it is necessary to suspect illusions in the experiment and defects in the apparatus.

We find the following very instructive note in Mr. Vidal's *Moniteur de la Photographie*. It serves to justify our restrictions.

"The *Journal* of the Photographic Society of India has this year given a reproduction of some photographs obtained in the Himalaya Mountains. In one of these photographs the image of a man situated in the foreground is entirely transparent and allows the stones and other objects lying upon the snow to be seen through the body and legs. It is very positive that there was no accidental double exposure. Yet, this subject having been discussed at the London Photographic Society, it was concluded that there must have been a double exposure unbeknown to the operator, and Mr. Debenham cited a similar phenomenon that had been observed in England. In this case, it was proved that the second image had been produced by rays that had traversed a very small aperture in the camera unbeknown to the operator. It was simply an aperture caused by a screw that was wanting."

A photograph that we have received from Dr. P. Bernard, of Lille, appears to offer an analogous phenomenon. This photograph, which we reproduce in Fig. 3, represents the city hall of Hondschoote, in Belgium. The windows of the edifice seem to be reflected upon the ground in front; but it will be seen that they are not inverted, as would have been the case had there been a direct reflection. May there not have been here a slight image obtained before the definite operation?

Mr. Hamel, municipal counselor of Biarritz, has sent us a photograph of the same kind, in which a belfry is reflected in space. Is there here again a double impression. Is there a mirage? Operators to whose eyes such images have presented themselves during development should take good care to assure themselves that there is not the smallest hole in their camera.

However this may be, it does not seem doubtful that

FIG. 3.—WINDOWS OF THE CITY HALL OF HONDSCHOOTE REFLECTED IN THE FOREGROUND.

a mirage exists at least in the first photograph that we have mentioned. There are here facts of interest to study and elucidate. We are persuaded, moreover, that the publicity given by *La Nature* to these photographic curiosities will have the effect of attracting the attention of physicists to the subject of them, and of leading, with new observations, to completer explanations.—*La Nature.*

TRANSPARENT SOAP.

THERE are many recipes for the manufacture of transparent soap, but out of the number there are a good many which are liable to give disappointing results, because the soaps so made do not retain their transparency. In order to make transparent soap in the most successful way the warm process is preferable to the cold. The following is a process which has been recommended for practical use, where a good soap is required without employing alcohol: 48 lb. of tallow, 42 of cocoanut oil, 60 of castor oil, 90 of a 35° Baume lye are taken, and the fats saponified by running in the lye. The mixture is then covered and the temperature allowed to rise to about 200° F.; 40 lb. of sugar dissolved in 42 lb. of water, 10 lb. of glycerine added, and the whole brought to a temperature of about 175° F. When the soap begins to form a thick clear mass with only a very thin skin, 16 lb. of sal soda, after being finely powdered, is thoroughly crutched in. Should the amount of soda specified be insufficient to make the soap quite hard, another two or three pounds may be added. After cooling to 140° F., any desired color dissolved in hot water is then crutched in till the temperature sinks to 130° F. If a heavy scum appears on the surface before coloring, there is not enough water, and the soap will not come out clear. Sufficient to render it so must therefore be added. The soap is then ultimately framed.

It is as well to note in connection with the preparation of transparent soaps in general that it is important that the exact quantities of fats and oils are taken, in order to accomplish which it is best to weigh off the quantities after melting and clarifying the same.

Also the soap will look better the older and drier it is before pressing, previous to which operation it is advisable to slightly warm the cakes, though this is not essential.—*Chem. Tr. Jour.*

THE MANUFACTURE OF LIQUORS AND PRESERVES.*

By J. DE BREVANS, Chief Chemist of the Municipal Laboratory of Paris.

CHAPTER II.—*Continued.*

SECTION II.—PURIFICATION OF ALCOHOL.

THE industrial alcohols which have already been described are obtained by a preliminary distillation in

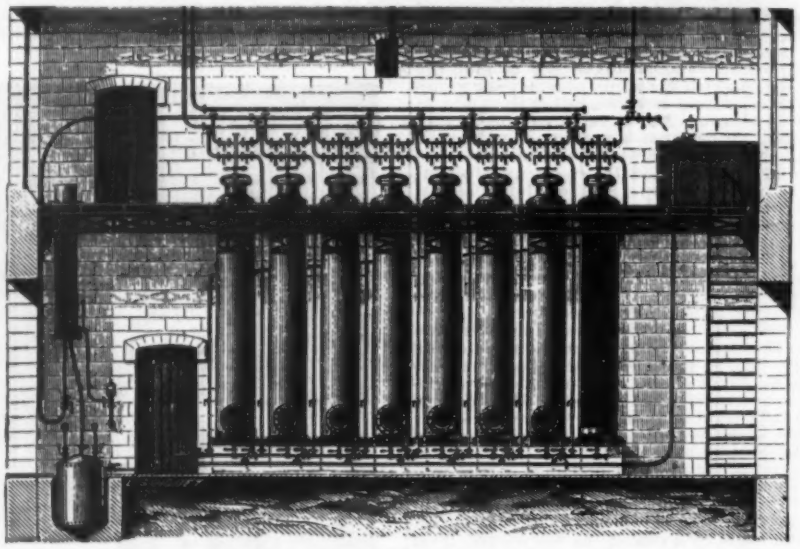


FIG. 13.—BATTERY OF ALCOHOL FILTERS—SAVALLE SYSTEM.

the state of what is called in French *flegmes*. By this name is understood aqueous liquids containing 45° to 75° of alcohol. These flegmes contain other impurities which are more volatile than ethyl alcohol; for example, the aldehydes. To rid the alcohol of these and other impurities is the reason why the alcohol should be rectified. Rectification is dependent upon fractional distillation; that is to say, the separation of liquids by order of their volatility. In the alcohol manufacturer's language, there are five classes of liquids, that they name as follows: 1, poor alcohol; 2, middling good; 3, fine alcohol; 4, extra fine; 5, absolute alcohol. Two methods are chiefly employed in the purification of alcohol: 1, the physical method, which includes rectification, use of absorbent materials, electricity, etc.; 2, the chemical method, in which substances are employed which have the property of destroying the principal impurities and the disagreeable odor.

Physical Method.—Several years ago the filtration of alcohol through animal black (bone black) was in favor. The price of materials having increased, it was found necessary to abandon the process. In Germany and Sweden they largely employ wood charcoal. The filters are large tubular vessels provided with two bottoms. These filters hold about 150 kilogrammes of charcoal, each filter permitting of the filtration of 60 liters of alcohol at 50° in 24 hours. In the construction and management of these filters the utmost economy must prevail. Fig. 13 represents a battery of filters arranged according to the best practice. Calcined charcoal must be used. Unfortunately, charcoal does not possess its remarkable disinfectant qualities for a great length of time and the revivification presents many difficulties, so that it can be only pursued in a country where charcoal is cheap. Oils are very good absorbents of the odorous principles, but their application in regard to alcohol is very limited.

Soap has been equally recommended by M. Kletzinsky, as a deodorizer, etc. For 20 liters of poor alcohol use one kilogramme of Marseilles soap. Alcohol distilled by this method has no odor and is more concentrated than the primitive alcohol, the soap retaining the water. The soap can be used over again by removing the impurities by a current of steam.

Chemical Method.—The chemical substances employed for the purification of alcohol are divided, according to M. Larbaletrier, into four groups.

1. Oxidizing Agents.—The metallic oxides, nitric, chromic, hydrochloric and other acids; the permanganates, the hypochlorites, ozone, oxygen, air, etc.

2. Substances used empirically without explaining their mode of action, such as sulphuric acid and alum.

3. The method of M. L. Naudin, in which, on the liberation of hydrogen, the aldehydes absorb two equivalents of hydrogen, which transforms them into the corresponding alcohols. Alcohols which include a large proportion of aldehyde, ethylic, propylic, butyric, and other compounds are acted upon by the hydrogen produced by electrolysis, which acts upon them, producing ethylic, propylic, butyric and amylic alcohols.

4. Products in which the action is due to certain special properties; for example, the alkalies (potassium, sodium, ammonium), lead acetate, etc.

SECTION III.—RECTIFICATION OF ALCOHOL.

The rectification of alcohol necessitates three series of operations. The first comprises the distillation of alcohol at a temperature of 68° (C.) This first operation gets rid of the ethers and the more volatile alcohols and a part of the aldehydes. The second operation, which is conducted at 68° to 100°, gives a good quality of alcohol, mixed, however, with aldehyde.

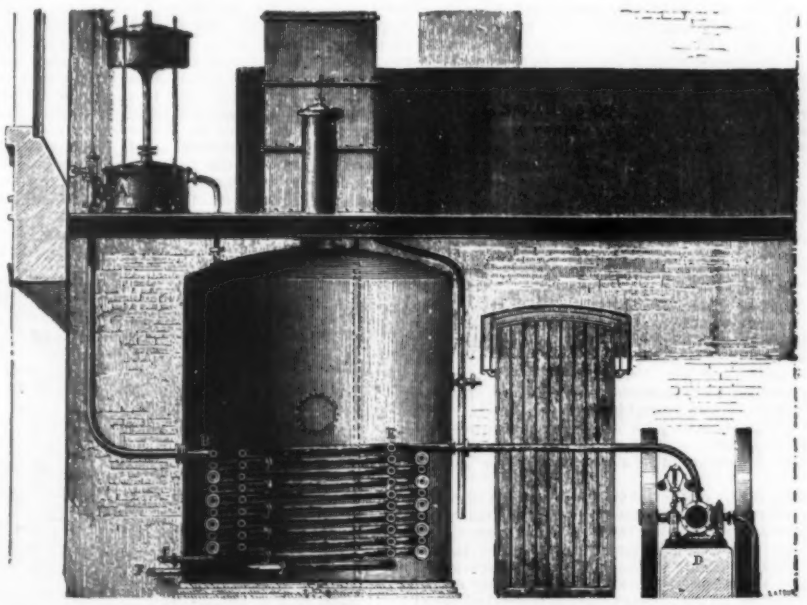


FIG. 14.—METHOD OF HEATING RECTIFIERS—SAVALLE SYSTEM.

From 100° to 102° the remainder of the alcohol distills, which constitutes the third operation. The part lost in this operation is 5 per cent.

Apparatus for Rectifying.—The apparatus generally employed (in France) is that of M. Savalle and of M. Deroy. There are two systems employed by M. Savalle. The one necessitates the application of water for cooling the condenser, and in the other this operation is performed by a current of air. The exhaust steam of an engine is used in this apparatus to heat the still (Fig. 14). This steam is conducted in coils around the inner portion of the still. A regulator governs the temperature and allows the proper temperature for distillation to be maintained. Two hundred thousand liters of alcohol a day can be rectified in this machine, as it is of very large size.

* Continued from page 14095, SUPPLEMENT No. 882.

The apparatus is put in operation by charging the still with the alcohol at 40° to 50°. Steam is then admitted into the serpentine coil of pipe. The liquid heats slowly and the vapors rise through the column, which gradually becomes heated, to the tubular con-

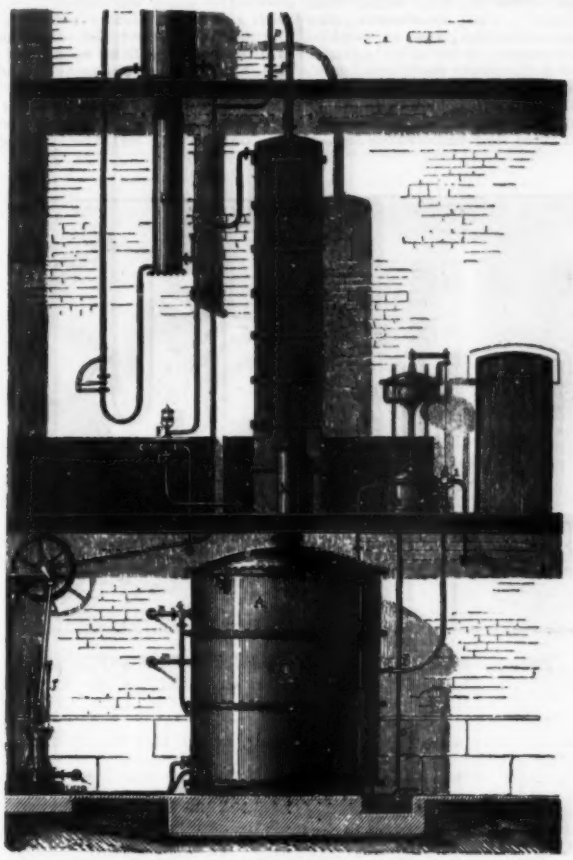


FIG. 15.—SAVALLE APPARATUS FOR RECTIFYING.

denser, when water is admitted and the vapors are condensed.

The Savalle apparatus for rectifying alcohol by using air to condense the vapors is represented in Fig. 15. It consists of a still, A, which receives the alcoholic liquor at 45°. In the interior is a steam coil. B is the rectifying column; C and D being condensers. The least volatile vapors are condensed in C. The vapors which are not condensed in C pass into the refrigerator, D, where they are condensed. The still is filled with alcohol to be rectified and the alcohol is poured on the plates. By this means the column is washed and freed from the empyreumatic products of the preceding rectification, and, when the operation is started again, the plates will be charged with alcohol of great strength. This proceeding is economical of fuel. The apparatus being started, the alcoholic vapors rise and are condensed little by little on the plates. This liquid emits in its turn vapors containing very little water, which escape from the column and are analyzed in the condenser, which is formed of a tubulous cylinder, the tubes of which serve for a passage of a current of air which replaces the water. The pure alcoholic vapors which traverse the condenser then go to the second condenser or refrigerator, while the aqueous vapors which are condensed are returned to the column. The second condenser or refrigerator works equally well with air. The apparatus of MM. Deroy is composed (Fig. 16) of four parts, the heater, or still, the column, the condenser and refrigerator. The heating is generally done by steam, as it must be gradual. The more volatile portions commence to pass over at 78°, while the alcohol does not really begin to distill until 80° are reached. The vapors rise in the column, where they encounter the plates, which arrest the least volatile portion, while the lighter portion is condensed or a second separation takes place, until the alcohol arrives at the refrigerator. Meanwhile the product of the latest portion of the vapors requires another separation, because the vapors condensed immediately after the ethers have not acquired the fineness necessary for the first quality, their strength being rarely 92°, while the best should be 95°. For a second operation the heat is withdrawn and the entire apparatus is thoroughly cleaned.

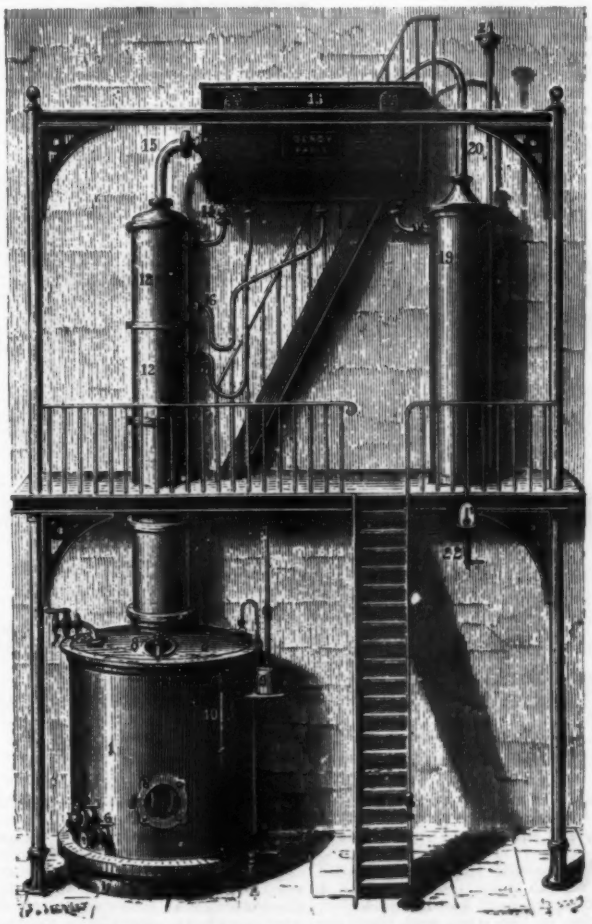


FIG. 16.—DEROY FILS AINE SYSTEM OF RECTIFYING.

(To be continued.)

THE INTRODUCTION OF REINDEER INTO ALASKA.*

THE Bear arrived at Port Clarence, upper Alaska, on June 26. She sailed for the Seal Islands from the island of Unalaska on May 26 and arrived at the island of St. George the next day. No other vessel had been seen from there since the Bear's departure south, December 1, 1891. On June 3 the Bear touched at St. Matthew's Island, which has been supposed to be overrun with polar bears. Last year the sailing schooner Mattie Dyer left three men there to hunt the animals. One of the party, Peter Viani, was found, who was reduced to extremities as to food. He had secured during the winter but one large bear skin and one small one, and desired to be taken off, which was done. The other two men had gone in a dory to Hall's Island, May 4, taking along provisions for but a week, and expecting to return in less time, but nothing had been heard from them. The Bear made search for them on Hall's Island and others neighboring, but in vain.

It seems the polar bears go on St. Matthew's Island to hunt, and, when the ice moves away, as it does quickly sometimes, with a southerly wind, some are left there. The number varies from year to year.

The Bear next proceeded to Cape Navarin, Siberia, to buy reindeer to supply missions and stations on the Yukon River, but could not land, owing to the heavy sea running.

The Bear then steamed for St. Lawrence Island, which is the first place in Alaska where whalers touch in going north in the spring. The whaling takes them close along the Siberian shore, except where they pass through these (Behring) straits, and they are almost wholly on the other side of the boundary line of Alaskan waters until they come into this part to refit after the spring whaling is done. Upon searching the village for liquor, the officers of the Bear found two drunken natives, who had just drank "to save it" what remained of two bottles of alcohol. The alcohol was part of a barrelful that had been brought there, and one of the natives let the contents escape on the ground and tried to conceal the barrel from the officers.

On June 11 the Bear sailed for King's Island, where fog and ice detained her several days. On the fourteenth one of her propeller blades was broken off in the ice, which reduced the speed a knot and a half.

The natives who were succored by the Bear in September, 1891, had survived the winter and were very grateful to the Bear.

The spring catch of the whaling fleet, as duly reported at St. Clarence Island, has been but eight whales in all—one of the smallest known.

The Bear being the sole representative of the government in all that region of northern Alaska, the duties and responsibilities devolving upon her officers are many and exacting, especially in the settlement of differences and starting of new enterprises incident to the growth of the territory in trade and population. The services of the officers are eagerly sought by all law-abiding residents, natives as well as whites.

Capt. Healy devoted some time to procuring an experimental herd of reindeer and the establishment of the station projected by the Interior Department in Port Clarence.

The Bear arrived at St. Lawrence Bay, Siberia, July 2, and fifty-three reindeer were purchased and landed on the north side of Port Clarence, near Grantley Harbor, July 4, where the station had been established.

At Enchowan, Siberia, sixteen reindeer were procured on the seventh, and added to the others. On July 15 six reindeer were taken aboard, and on the nineteenth, twenty-one more were bought.

Capt. Healy reports that the ice had been troublesome and heavy during all the season, on the Siberian coast, while the Alaskan shore was free and open as early as May—a result due to the prevailing easterly winds, which drove the ice over against the west shore and packed it. No fixed rules can be set for its movements and no two seasons find it the same. Only careful attention and inquiries along the coast as to the immediate condition of the ice can insure a vessel's safety.

The reindeer procured at Cape Sevdze-Kamen were landed at Port Clarence July 22. A native who had procured a breech-loading rifle was soon compelled to return it, under penalty of the law. At Holy Cross Bay, after much hard work by the boat party, twelve reindeer were secured. These were landed August 12. A house for herd was completed at this time. The total number of deer thus transported was 177. Capt. Healy states that hereafter the animals can be procured more easily, for prejudice and objection to the sale has been removed and knowledge of the annual purchase has been disseminated inland, so that they will be assembled on the coast next year, ready for sale and shipment. The natives are interested in the experimental station, and inquiries about the animals were made of the officers and crew all along the shore.

The number of wild deer in the country is not sufficient to furnish the natives with clothing, and hence they purchase skins at high prices, from whale ships sailing from the Siberian coast. Every part of the animal has a high commercial value, and rearing it is a lucrative business.

Two sled deer were taken to St. Michael's trading station for experiment, and next year it is desired to supply the missions and stations along the Yukon, where they are greatly desired. Those left on this

* Abstract from reports of Capt. M. A. Healy, U. S. S. Bear, dated respectively June 29 and September 25, 1892, to the Secretary of the Treasury.

island last year have prospered well and some are now with young.

At Point Hope the Bear found the people had been unsuccessful in whaling and sealing the past winter, and many were moving away to places where the food supply was greater. Every year food is scarce here or there, and assistance is required to enable the people to exist through the winter.

The pursuit of whales far to the north has led some whaling vessels to winter at Icy Cape, so as to be near the whaling ground when the season opens. One steamer came out in 1890 with a catch of thirty-nine whales—an extraordinary success.

The season has been particularly open, and nearly the whole of the whaling fleet had gone east of Point Barrow when the Bear sailed south. The encouragement and assurance given them by the refuge station with its supply of provisions near by in case of accident, where heretofore they would in such cases be at the mercy of the elements, has enabled them to go farther and to more profitable places in pursuit of their business, and contributed greatly to their success.

At points where the Bear touched, diligent search was made for liquors, but none were found, save in a very few instances. Capt. Healy says: "I have used my most strenuous efforts to prevent the introduction of liquor into the country, have searched all the vessels of the fleet and the villages thoroughly and have been watchful of the trading with the natives; and outside of the case at St. Lawrence Island, and possibly a few bottles here and there that may possibly have been smuggled in by irresponsible officers or members of the crew of some of the vessels, I have no hesitancy in saying no distilled liquors have been introduced into Arctic Alaska during the present season. It is an extensive country and there are many people and ships for one vessel to watch, but I have used the best endeavors of my command on this point, and am assured that I have driven the liquor traffic out of the country.

In some places (Point Hope, Cape Smythe, and Point Barrow) the natives have learned to distill a vile compound from molasses, sugar, flour, bread, wild berries, etc. This is mostly done in winter, with a tin can and a gun barrel or even a piece of sea weed for a worm. Knowing the character of the vessel (Bear), these are taken apart and buried in the summer and I am at a loss to stop this manufacture with the short stay I can make in the country. It has reached no great proportion, but must surely work harm to the natives if it increases.

At Point Barrow the Bear took on two young men who had spent five years of privation collecting whalebone—which has now reached the extraordinary value of $6 and $7 a pound.

On his return trip, Capt. Healy found the reindeer herd had prospered and was in excellent condition. Being selected, the animals are mostly young and sound, and the officers assert it is better than any herd seen in Siberia.

There are seven schools on the coast from Unalaska to Point Barrow, not counting the two on the Seal Islands, seven in the interior on the Yukon and Kouskakrin Rivers, and arrangements under way for the establishment of others. But, with three exceptions, these are contract schools, being established by religious organizations and subsidized by the United States Bureau of Education, Department of the Interior. The schools are severally under the care of the Methodist, Moravian, Russian, Roman Catholic, Episcopal, Lutheran, Congregational and Presbyterian Churches.

EXPERIMENTS ON CAPILLARITY.

ONE of the distinctive characters of capillary phenomena is their excessive variability, which is such that they seem to be amenable to no law. This is a sign of the delicacy of the actions brought in play and of the multiple disturbing causes to which they are submitted, that is to say, of the universality of such actions. Certain experiments on capillarity are difficult to perform successfully, since it is only by surrounding one's self with the greatest precautions that one succeeds in seizing in the flight a phenomenon of relative purity. A few figures will allow to be understood to what extent the least foreign actions may entirely vitiate the phenomena. Camphor vortices, as well known, are produced only upon a relatively clean surface of water.

Lord Rayleigh has shown that a film of oil of two millionths of a millimeter, uniformly spread over the water, suffices to arrest them completely. A film of this thickness would weigh less than two milligrammes per square meter of superficies; and yet it is coherent, that is to say, it contains, further, several superposed molecular films. This simple experiment shows us, then, that a cubic millimeter certainly contains more than a hundred thousand billions of molecules.

In reality, it contains a much greater number. For a cause quite analogous to that which puts a stop to camphor vortices, water as a general thing refuses to spread out over mercury, as, according to general laws, it should do when the two surfaces are perfectly clean; and, in fact, there are few physicists, even among the most careful ones, who have succeeded in obtaining the pleasure of observing this phenomenon. Yet, thanks to a few artifices, one may succeed therein; but after a good surface of mercury has been obtained, it must be used as quickly as possible, since it is almost instantaneously contaminated. It becomes soiled in every experiment after it has been touched with a platinum wire that one has simply passed between his fingers. We can mention no figure that indicates the approximate thickness of the layer of grease that is then found upon the mercury, but it is certain that it is infinitely feeble.

One of the characters of clean liquid surfaces is their extreme mobility. We know how difficult it is, under ordinary circumstances, to obtain a surface of mercury without any undulations. Astronomers, who frequently have need of a perfectly horizontal mirror, often employ to this effect an amalgam rich in mercury, more viscous than the pure metal.

Yet the mobility of an ordinary surface of mercury is nothing as compared with that of a freshly formed surface. The infinitesimal contaminations of which we have spoken suffice to considerably reduce the undulations of the surface, and to thus give us an image on a small scale of the effect that a thin film of oil can produce on the surface of the sea.

A contaminated surface possesses a sort of rigidity that it is easy to observe. When a basin full of water has been exposed to dust, the surface may be cleaned by passing blotting paper over it; but when this operation is undertaken, here is what we observe: the surface of the water recedes before the paper as would a thin stratum of a solid substance; it turns up against the edge of the basin, and if the paper be drawn back, the dust closely follows it; if the *entire* superficies be not swept, it is always as unclean. A surface of water that has remained for some time in the air without being renewed takes on that rigid and immovable aspect that has given rise to the picturesque and very exact term stagnant water. The rivulet that runs along sidewalks carries along, in most cases, dust or greasy substances, but if it meet with an obstacle on its passage, the superficial stratum is arrested and the water continues to flow beneath. On observing the bodies carried along, we may be convinced that the motion is often rapid, at least at a millimeter from the surface, while the latter appears absolutely rigid.

Certain experiments in capillarity may be tried with the greatest ease, and without any other apparatus than the commonest utensils.

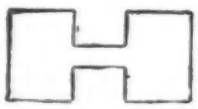


FIG. 3.—PLAN OF DOUBLE PAN.

Superficial tension differs from one liquid to another. It is stronger with water than with alcohol, as may be easily demonstrated. Pour a little coffee into a flat-bottomed saucer, revolved as need be, so that the liquid shall be well spread out; then allow a single drop of an alcoholic liquid to fall at the center. The film of coffee will be immediately pierced (Fig. 1), and, drawing from all sides, will leave the porcelain dry, while on the edges of the white circle thus formed we shall see, on a close observation, an energetic motion

After well cleaning the cover of a cracker box, it is placed horizontally and partially filled with water, over which one scatters a small quantity of flowers of sulphur or lycopodium. Upon then applying the finger to the under surface of the cover, we shall in a moment see the powder separate and leave a small open circle above the place warmed (Fig. 2). The effect obtained with a match is almost instantaneous.

A modification of this experiment permits of determining the superficial tension of slightly contaminated water. Two flat tin pans are connected by a narrow conduit (Fig. 3). A little water is poured into these, and one traces with lycopodium a line at right angles with the conduit. If a small drop of oil be placed in the pan to the left, the lycopodium will move to the right, but it can be brought back by heating to the right, that is to say, by diminishing the superficial tension of the pure water. Knowing the value of the latter at all temperatures, we deduce therefrom the value of the first.

FIG. 1.—DROP OF ALCOHOLIC LIQUID POURED UPON A FILM OF COFFEE.

The capillary forces, while raising or lowering the level of liquids in narrow spaces, exert also attractive or repulsive lateral stresses. It is easy to demonstrate that two floating bodies, wet by the liquid, must attract each other. The same is the case with two wet bodies. On the contrary, two floats, one of which is wet and the other not, repel each other. Two corks placed in the same vessel soon stick together, while if one of them has been previously dipped into paraffine it will be impossible to make them adhere.

Steel needles carefully placed upon water float thereon as long as none of their parts is wet. Two needles placed in the vicinity of each other soon adhere to one another, unless, in certain conditions, magnetic actions do not prevent it. On the contrary, if one pursues a needle with a finger dipped in water, it flies before it and one cannot catch up with it.

We know that a film of soap suds, after showing magnificent colors, becomes black just before breaking. This phenomenon, which Newton passionately occupied himself with, has tempted several modern physicists anew. Messrs. Reynold and Rucker, through ingenious processes, have measured the thickness of this film in its last state, and have it a trifle more than a hundred-thousandth of a millimeter. Now, we know that a soap bubble exerts a certain pressure upon the air that it incloses, and which is inversely proportional to its diameter. Let us suppose (what is easy to do) we put several bubbles one within the other. These bubbles will encircle each other mutually, and the air inclosed in the smallest will support the sum of the pressures exerted by all the bubbles.

FIG. 2.—LYCOPODIUM UPON A FILM OF WATER.

With a little practice one can succeed in forming very large concentric bubbles; but let us suppose the theoretical and practically irrealizable case in which we have blown, one within another, a very large number of bubbles thin enough to be black and of sizes so approximate that they are separated only by a distance equal to their thickness. If the smallest of the bubbles has a diameter of one centimeter and the largest a diameter of one decimeter, the pressure in the interior of the smallest will be about two hundred atmospheres. This result is so fabulous that it will find many unbe-

and a sort of combat as it were between the water and the alcohol. It is because the water, being the stronger, rends the surface of the alcohol and carries it along in all directions.

The alcohol gradually mixes with the water and the aperture closes. If we repeat the experiment with a cup previously moistened throughout its whole interior, we shall see the liquid rise to the edge, and then descend in small cascades. The spectacle is very curious and is capable of lasting for a long time.

Not only does superficial tension vary from one liquid to another, but, with the same pure liquid, it diminishes when the temperature is raised. The following is an elegant demonstration of this fact, due to Lord Rayleigh.

livers. We repeat that the experiment cannot be carried out, but it is not absurd. It is the most striking example that we have found of the utility of hooping cylinders submitted to strong internal pressures.—*La Nature.*

ARCHITECTURAL SKETCHES IN CHICAGO.

SOME rather bold sketches of Chicago architecture have been given in the London *Daily Graphic*, of which we here give examples.

The lower sketch is a view on Randolph Street, and

ARCHITECTURAL SKETCHES IN CHICAGO.

gives an idea of the elegance of that remarkable thoroughfare.

The upper building at the left is the new Masonic Temple, which fronts 113 feet on Randolph Street and 170 feet on State Street. The building rises 274 feet above the street level, has twenty stories, contains 5,436,000 cubic feet. Fourteen elevators carry the people up and down, who are numerous enough to populate a small city. The sketch at the right is the Woman's Temperance Temple, which has 100 feet front on La Salle Street and 96 feet front on Monroe Street. It is thirteen stories high and cost $1,100,000. Architects, Burnham & Root.

[NATURE.]

THE TOTAL ECLIPSE OF THE SUN, 1893.

As I have been asked by some astronomers to give a description of the general appearance and climate of this part of Chile, in which a total eclipse of the sun occurs next year, I have drawn up for publication the following account:

The eclipse takes place on April 16, 1893, at about 8:15 A. M., Chile local time, and will be seen to the greatest advantage in this part of the Province of Atacama.

At the sea coast the central line of total eclipse passes close to Chanaral 29° S. L. This is not the better known Chanaral, north of Caldera, but a small place equidistant from Coquimbo and Carrizal Bajo. The southern limit of total eclipse is 29° 50' S. L., just north of Coquimbo, and the northern limit 28° 10', just south of Carrizal Bajo.

The band of total phase stretches between these two limits in a northeasterly direction, across the country, from the coast toward the rising sun. Along the central line of this band the sun will be hidden by the moon for nearly three minutes. The eclipse will be total everywhere within the limits given above, but the total phase will be shorter and shorter the nearer those limits are approached, and outside of them the eclipse will be partial.

On the accompanying map of the Carrizal and Cerro Blanco and Copiapo Railway systems I have marked the northern and southern limits, and the central line of totality.

It will be seen that the port of Carrizal Bajo, 28° 4' S. L., is just outside the total band, but the railway connecting it with Yerba Buena intersects the central line of total eclipse 70 miles inland, and a branch to Merceditas, 60 miles inland, at an altitude sufficiently high to be above the damp and hazy atmosphere of the coast. At the points of intersection the climate is simply perfect for astronomical observations, and is also, during the month of April, delightful to live in.

I had two series of observations made, one at Mina Bronces by Mr. Martin, chemist to the works, the other at Cerro Blanco by Senor Miranda at his mine. Both reports are in every respect alike. The 10th and 27th were cloudy, all the other days absolutely clear. As the two stations are some twenty-five miles apart, these reports show that there is no local weather, and that it is only when a general atmospheric disturbance,

originating in the Cordillera de los Andes, occurs that the weather is affected at these high stations.

There was only one day—the 27th—out of twenty-one days of observation on which the sun was not visible at eight o'clock in the morning, for on the other cloudy day—the 10th—the sun was bright at intervals.

Observatory Stations.

I have marked on the map, along the central line of totality, several stations that I think suitable for observatories; the positions are only approximately correct, for I have no means of determining them accurately, but the errors, if any, cannot be great.

Undernoted are heights above sea level of some places shown on the map:

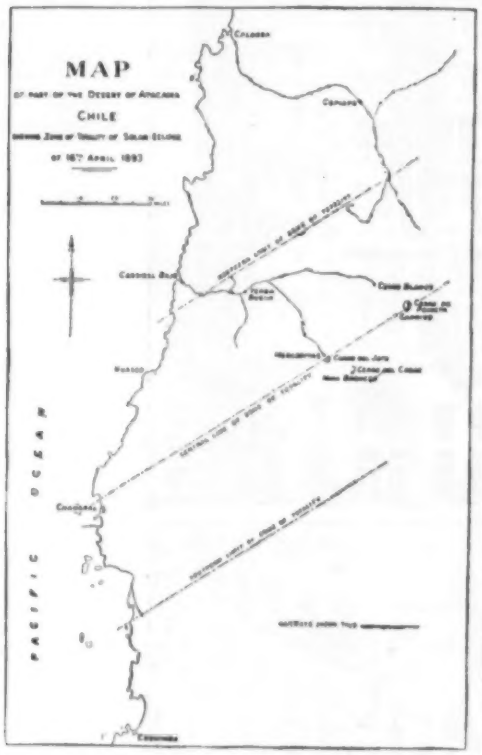
Yerba Buena railway terminus	3,867 feet.
Cerro Blanco, north hill	10,000 "
" south, Peineta	8,000 "
Carrizo, in the valley, a small farm	5,000 "
Merceditas railway station	2,900 "
Cerro del Jote	6,000 "
Cerro del Cobre	8,000 "
Lay observatory	4,000 "

Cerro de Peineta is part of Cerro Blanco; this Cerro Blanco is not part of the Andes, but a detached hill with low ground all round, and a clear view to the northeast. It is easily ascended by pack mules.

Carrizo is not a hill, but a small farm or large garden, irrigated by a mountain stream. The advantages of this station are: nearness to the railway, a good road, and plenty of small hills of easy ascent to select from.

Cerro del Cobre is a good hill, but probably too far south. However, there are hills all the way from Merceditas that might be selected (see Mr. Martin's letter).

Serra del Jote, near Merceditas, is accessible to pack



mules half way up, higher than which it would not be necessary to go. Moreover, it is said that the rest of the ascent is difficult. The three hills, Cerro de Peineta, Cerro del Cobre, and Cerro del Jote, can all be seen from one another.

Lay Observatory.—On April 15 I went to Merceditas and stayed overnight, as I wished to find near the railway station a hill on which the sun shone at an early hour on the morning of the sixteenth, through some opening among the surrounding hills, and which would be suitable for ordinary lay observers who had no expensive apparatus, but who wished to see the eclipse well through a smoked or colored glass. To the south of the railway station I found a range of hills eminently suited to the purpose; at a height of 4,000 feet above the sea the sun shone over a dent in the Jote at 6:40 A.M. The hill is much higher than 4,000 feet, but I did not go higher. This is an excellent, well sheltered spot, and would do well as a station for professional astronomers. I went up on horseback in forty minutes, but the ascent from the railway station could be easily made on foot in an hour. As I could not find any local name for this hill, I called it the Lay Observatory.

Climate.—At two o'clock in the afternoon of April 15 the temperature at Merceditas was 78° F.; this was the hottest time of the day, and it was a warmer day than usual, and at 8 P. M. the temperature was 62° F. Next morning, the 16th, I got up at two o'clock to see the comet then visible, and found the temperature was 58°; at 5 A. M. it was 56°.

Everywhere on the coast of Chile, north of Coquimbo, the sun, in the morning, is almost always obscured by a thick haze which makes the sky of a dull lead color. This haze is sometimes driven away by the sun during the forenoon, but just as often it remains all day, especially during the months of March, April, and May.

This hazy morning atmosphere extends inland for a distance of about 40 miles and up to an elevation above the sea of about 2,500 ft. Beyond this distance and height the sky is almost always clear and the air dry. Standing, in the early morning, on a mountain of 3,000 to 4,000 ft., or higher, you look down on a great white sea of mist covered with whiter ridges like motionless waves, and studded here and there with islands, which are the mountain tops piercing through. This haze is usually gone by nine o'clock, except within about five miles of the sea.

Accommodation on the Hills.—Tents can be quickly and cheaply made with "esteros de totora," that is mats made of reeds. All the more temporary houses of miners and prospectors and of railway track repairers are made of these mats, which are seven feet square and may be rolled up and carried from place to place. They form an article of commerce, and cost eighteen pence each, or from eighty to ninety cents of Chile paper currency. During all the month of April and part of May it is quite safe to trust to this kind of tent, but not later than the middle of May, for rain or snow sometimes falls in the end of that month.

There are no venomous reptiles in Chile, nor are there mosquitoes on these hills, and fleas cannot live at an altitude of 4,000 ft.—no slight advantage.

Rain.—On the Chilean side of the Andes, in the province of Atacama, rain generally falls twice in the year: the first rain is expected in June, the next in July, each rain usually lasting two days, and always accompanied with wind from the north. As soon as the wind changes to its prevailing quarter, the south, there is beautifully clear but cold weather. From two to three inches of rain fall in the year, but sometimes less than one inch. On Cerro Blanco it usually freezes every night from July till the end of August, and some snow lies on the mountain till September. On the hill sides there are plenty of bushes and small trees for fire wood, and excellent water is found in all the higher valleys.

I have heard one objection to this district for observing the eclipse, which is that, as the eclipse takes place in the morning, and the sun is not high in the sky, it would be better to go farther east. This objection has no weight, on account of the extreme dryness of the atmosphere. At the mines on Cerro Blanco and the other hills every thing gets dried up; Huasco raisins grow hard and rattle on one's plate like nuts; agricultural produce, such as wheat, beans, and barley, brought from Southern Chile as food for man and beast at the mines, loses two per cent. of its weight every month for several months, office ink bottles have to be kept tightly corked or the ink very soon dries up, chairs and tables fall to pieces, veneer peels off, and a piano soon loses its tone. The sky is dark blue, and the sun rises white and dazzling without a trace of any other color. The hills, the rocks, and the bushes cast dark shadows, and even every pebble the size of a hazel nut casts its shadow, so that in the early morning the gravelly ground seems half wetted with a shower; one side of every pebble is in bright light, the opposite in deep shadow.

Although the eclipse would be the object of greatest interest to visitors, a few weeks might be profitably spent among the copper mines, and if any one wished to become a mine owner, plenty of mines are to be had for the asking. All the mines belong to the state. You have only to take up a mine, pay a nominal license to the government annually, and the mine is yours as long as you pay the license. There are no royalties, no surface rents, and no export duties. The next thing to do is to make the mine pay, and this is sometimes done.

There is no sport in April, but after snow falls on the Cordillera, huanacos and immense flights of turtle doves come down to feed on the lower slopes. Life, however, is never wanting. The region from Cerro Blanco southward as far as Coquimbo is the home of the fur chinchilla. It feeds on the nut of the carbon tree, *Cordia decandra* (Hook. et Arn.), and on the pea of the algarrobillo, *Balsamocarpon brevifolium* (Clos.) This bush, which produces the tannin pod of commerce, thrives best far inland, on sunny, almost rainless slopes, but it must have one shower in June or July, otherwise it bears no fruit. If there be no rain for three or four years—as sometimes happens—the bushes do not die, they just wait. The same thing happens with all the other bushes; sometimes, for several successive years, they are without leaves, and though the soil seems as dry as dust, whenever rain comes they show themselves full of life.

British astronomers—professional and amateur—ought not to lose the opportunity of observing under such favorable circumstances this great eclipse. I doubt if better conditions were ever offered before. The distance to come is long, but the expense is not very great, and can be exactly counted beforehand. An expedition might leave Liverpool in February, by Straits of Magellan steamer, and be home again in June. Or, after the eclipse, go by steamer to San Francisco or Vancouver, and thence by rail to the World's Fair at Chicago, and instead of encountering hardship and danger in some unhealthy climate, have a pleasant trip all the way.

Though horses and mules can be got here, every one should bring a saddle and bridle.

In conclusion I would impress on the members of every expedition that may come out the importance of selecting, as observing stations, places at a distance of at least 60 or 70 miles from the sea. On the other hand, the advantages of going farther inland are doubtful, and as the railways go no farther, traveling would be more difficult.

JOHN KING,
British Vice-Consul, Carrizal Bajo, and Engineer of the Carrizal and Cerro Blanco Railway.
Carrizal Bajo, Province of Atacama, Chile, May, 1892.

SERPENT LATELY SEEN ON THE AFRICAN COAST

ANOTHER SEA SERPENT.

THE officers of the Liverpool mail steamer Angola, lately arrived in Liverpool from the west coast of Africa, report that while steaming off the coast between Bey Reach and Lagos, a long moving mass was made out about a mile from shore. Closer examination showed it to be an immense serpent. The attention of the whole of the officers, crew, and passengers on board the Angola was directed to the creature. There were no fins or flappers visible. The serpent was moving through the water at about six miles an hour, with apparently an undulating, wriggling motion. It was traveling in an opposite direction to the Angola, and was kept in sight for quite ten minutes. The serpent's length was estimated at about 200 feet, and its body seemed to rise several feet above the sea surface. The water at the time was smooth, and an unobstructed view of the monster could be obtained. At one time it raised an enormous head, and glared at the ship as it seemed. So impressed were those on board with what they saw that a written record of the fact was drawn up and signed. As is usual in cases of the kind, the signatories have been subjected to a great deal of ridicule, but they are nevertheless convinced that the monster they saw was a marine mystery and a sea serpent.—*Daily Graphic.*

HIPPOPOTAMUS HUNTING.

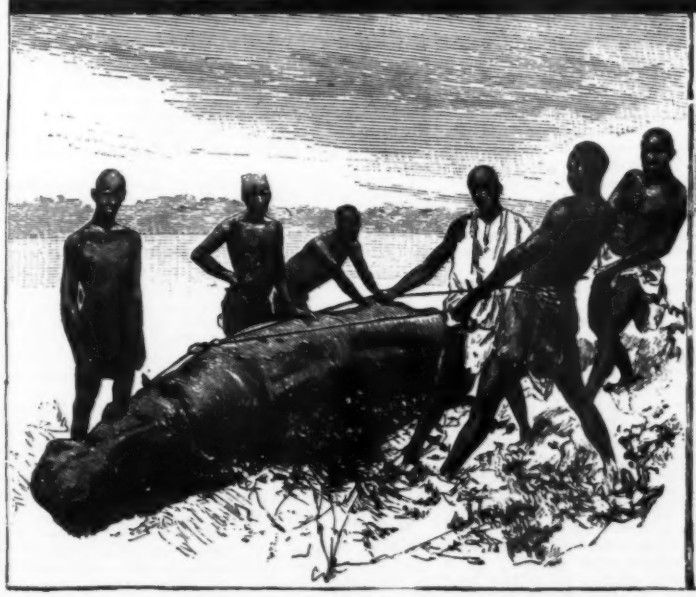
THE hippopotamus is an animal that is met with only on the African continent; in return, in some parts of this country it swarms to the point of interfering with the navigation of the watercourses. Let us hasten to say that in measure as Africa has been penetrated by the whites, the animal has learned to know long range weapons, and especially to dread the perforating power of our guns. Up till then the bad trade guns of the aborigines, their round balls and their detestable powder, had remained almost harmless against these animals, the thickness of whose hide has caused them to be classed in the first rank of pachyderms *par excellence*. So they are becoming more and more suspicious, and, at least in the frequented regions, allow themselves to be approached only with difficulty.

The natives, who are very fond of their flesh, which, by the way, is very palatable, and similar to that of the ox, eagerly hunt them when occasion offers, or capture them by means of traps in the form of deep

pits excavated on their passage and covered with branches.

Our engravings represent a hippopotamus that was shot by one of our correspondents, of Upper Senegal. The animal, surprised at a moment when it was climbing up the bank in order to get on land, was quickly killed, and fell at the water's edge. As seen from the back in one of our engravings, it exhibits the aspect of a huge hog. Another engraving shows the monstrous head of the animal and its large muzzle bristling with short, coarse hairs.

Scarcely had the beast fallen, when the inhabitants of the banks ran to the quarry. Ropes were passed around its body, and double parallel slits were cut in its body that served as handles to draw it up on the bank, where it was cut up in the twinkling of an eye by a hundred butchers of the occasion, who struck it with heavy saber cuts at the risk of maiming each other. Flesh, entrails and everything else was removed, and nothing remained but a vast pool of blood, which slowly flowed into the river, the water of



HIPPOPOTAMUS HUNTING.

1. Head of hippopotamus—the animal lying at the edge of the water. 2, 3, The negroes dragging the animal up the bank. 4. Cutting the animal up.

which remained tinctured for some time up to a certain distance.

In the evening, there was feasting in all the huts of the vicinity, and the tam-tam, accompanying the most picturesque dances, resounded until daybreak.—*L'Illustration.*

SOME OF THE PALE HARD WOODS OF NEW SOUTH WALES.*

By J. H. MAIDEN, F.L.S., etc., Curator of the Technological Museum, Sydney, and Botanist to the Forestry Department.

THERE is no doubt that if the phenomenally difficult genus Eucalyptus is to be conveniently studied, it will be found necessary to subdivide it in some practical manner. It will be found desirable to break it down on account of its size alone, as it comprises, for the whole of Australia, no less than 136 species (of which 53 are found in New South Wales), not to mention a very large number of varieties, while fresh species are still not infrequently discovered. Eucalypts are conveniently grouped according to their barks, and two of the best defined groups of our hard woods, viz., the ironbarks and the stringy barks, are obtained in this way. I have not, however, seen our hard woods grouped according to *colors*, but I think that such a classification will be found useful, and, as our knowledge extends, degrees of difference in color between our various hard woods will be found which are scarcely appreciated at present. I propose this evening to deal with such of our hard woods as are free, or almost free, from a reddish tinge, and which vary in color when quite fresh from white to a very pale brown. For precision, I shall confine my remarks to the products of the genus Eucalyptus, which of course includes the vast majority of our hard woods.

Treat it as one will, the subject remains a difficult one if it be done with any approach to thoroughness. I will endeavor, as far as possible, to push botanical names and scientific phrases into the background, but I would venture to sound a note of warning in regard to quacks who profess to deal with our hard woods without any reference to scientific names. I am addressing a body of gentlemen whose training lies not only in the domain of art, but also of science, and I put it to you that, if you would desire more than a smattering of knowledge in regard to our hard woods, you will find it necessary to occasionally employ botanical names for the sake of precision. You will find that the same timber goes under different names in different districts, and the same name has been employed to designate more than one timber; hence, to avoid circumlocution, at any rate, it will be necessary to fall back upon botanical names sometimes, as landmarks or starting points. Of course, with some timbers, such as tallow wood, there is no ambiguity in this colony, but their number is very few. Tallow wood is tallow wood in New South Wales, one species and no other, although a voluble timber getter will, after vainly using all his powers of persuasion to prove to you that a certain timber is tallow wood, blurt out, "Well, it's a bastard tallow wood, then," which may mean anything. I therefore employ botanical names (in conjunction with vernacular ones), in this paper, simply to make it quite clear what particular timber I am referring to, and the vernacular names I use are those I believe it is desirable to employ, as far as possible, when referring to the particular species under consideration. In Europe, vernacular names have been in use so long that they have acquired precision of a high order, and an architect has only to refer to a timber by its vernacular name for a definite substance to be understood thereby. In our colony, the use of vernacular names as applied to native timbers has often led to uncertainty, disappointment, and dispute, and the architect who desires a fair acquaintance with our native hard woods must look the facts squarely in the face and endeavor to tackle the small amount of botany, or rather use of botanical terms, requisite for their discrimination.

My subject is a most appropriate one to bring before architects, as, in one part of the colony or another, every timber I shall bring under review is either used by them in the construction of buildings or, in case of some of the inferior ones, they are endeavored to be foisted on the architect under misleading names. I would like to remind architects, in passing, that there is some *kudos* to be obtained in designing furniture to be constructed out of our hard woods. I particularly allude to such massive furniture as tables, settles, etc. In large houses in Europe, such furniture is often made of oak, where weight is not considered an object, and I think that some of our hard woods may well be utilized as oak substitutes. I may remind you that one of our pale hard woods, white ash, is pretty extensively used in Sydney already as a substitute for English and American ash, and it is particularly suitable for bedroom furniture, presenting an excellent appearance. In classifying the pale hard woods of this colony, it is not possible to draw a hard and fast line between the pale ones and those which are not pale, but I hope eventually to be able to give a scale of timber colors. I have divided our New South Wales pale hard woods into three groups, viz.:

1. Hard interlocked timbers.
2. Fissile timbers.
3. Inferior timbers.

Which I submit as a practically useful classification.

In order to make my remarks as useful as possible, I show flower and fruit bearing twigs of the various species, and also specimens of their barks, for a knowledge of barks is indispensable to a student of hard woods. I may mention that I shall always be glad to advise architects as to the name of any particular hard wood, and give an account of our knowledge of the wood, if desired. It is always desirable to forward fruits, if possible, but in practice it is not always possible to match wood and fruits with certainty, and if there is a suspicion of doubt on the point, it is best to omit the fruits.

* Paper read before the Sydney Architectural Association, September 5, 1892.—*Building and Engineering Journal.*

GROUP I.—HARD INTERLOCKED TIMBERS.

BOX, WHITE OR GRAY BOX (*Eucalyptus hemiphloia*).—We have in this colony quite a confusing list of timbers which go under the name of box, of one color or another, to say nothing of those which are known as bastard box. There are two trees very closely allied botanically, viz., the box or gray box of the coast districts and the white box further back. They both yield well known and valuable timbers. Their pale color and hard, non-fissile nature have caused them to be called by the same name as the box wood for engraving, but the resemblance is slight. The piece of box before you has been taken from a pile in one of the bridges in the southeastern portion of the colony. You will observe that it is perfectly sound, although the pile has split badly. I mention this in view of the statement that box timber is usually stated to be subject to destruction by white ants and dry rot while standing in the ground. As regards white ants, I may mention that we require much more extensive observations in regard to their behavior to our native timbers before we can speak with much certainty on the subject. The special uses of box by the architect are not many. It is good for large wood screws, and for decking, planking in general, and for fence posts, rails, etc. It is useful for such articles as handles and mauls, which need toughness of wood for their manufacture. Another pale colored box yielding useful timber is the yellow box (*Eucalyptus melliodora*). It chiefly occurs in the western districts, and is used for posts and rails, and rough building purposes. It is not a large tree.

SPOTTED GUM (*Eucalyptus maculata*).—This is, of course, one of the best known of our timbers. The vernacular name is owing to the mottled appearance of the trunk, owing to the outer bark falling off in patches. It is one of the coarsest grained timbers of the eucalypts, and has a pretty, wavy appearance which is readily recognized, and which looks well under polish. For strength and elasticity it possesses but few equals. It is used for house building, for joists, studs, etc., and is very durable if not exposed to the weather; but it will not stand in the ground, *e. g.*, for telegraph poles. Nevertheless, it seems to be really a valuable wood for paving. Its use is, however, principally in shipbuilding. Unfortunately, this tree is often inclined to unsoundness, a characteristic which may have some connection with the fact that these trees often produce large quantities of gum (*kino*). In Queensland some people appear to be liable to an eruption on the skin when handling this timber, the complaint being known as "spotted gum rash." It would be interesting to learn whether the complaint is known in New South Wales, and, if so, particulars of individual cases would be desirable. Spotted gum and iron bark seem to favor the same localities, *i. e.*, the coast ranges and thence to the sea. They are to be found in great quantities near the Shoalhaven, Clyde River, Moruya, Wagonga, Readhead, Bermagui, and other places south of Sydney. Going north, we have Wyong, Ourimbah, Blue Gum Flat, Port Stephens, Cape Hawke, the Manning, Camden Haven, Port Maquarie, and as far north as the Clarence and Tweed. The spotted gum is in excess south, and the reverse is the case north of Sydney.

TALLOW WOOD (*Eucalyptus microcorys*).—In New South Wales this tree universally bears the above name, but in Queensland it also goes by the name of red stringy bark, and also peppermint, the foliage being remarkably rich in oil. I am not aware that our New South Wales oil distillers have turned their attention to this tree, and as enormous quantities of tallow wood are felled in this colony, and the leaves at present go to waste, I throw out the reminder in passing. Tallow wood is one of the most valuable of our timbers, and is deservedly held in high esteem by architects, who use it most largely for flooring, but also for palings, the turned pillars of veranda posts, and for a multitude of uses. Its name was given owing to its greasy nature (hence its usefulness for ball rooms), which is most perceptible when it is newly cut. It is largely used for the decking of bridges. In Queensland it has had to be protected by the legislature against timber getters. It is valuable for cubes for street paving. It is confined to the northern rivers; it does not come as far south as Sydney. It is plentiful in the Cape Hawke district.

BLACKBUTT (*Eucalyptus pilularis*).—There is probably no species of eucalyptus better known to Sydney people than this one. It is a most valuable timber, almost as strong as ironbark, and it is widely distributed along the coast districts. It is extensively used for building and fencing purposes, and for any purpose where strength and durability are required. While white ants are often found in the heart of trees which have been injured, or are sickly, they rarely attack the seasoned timber. Blackbutt is one of the most largely used woods for paving blocks. The liability of this timber to gum veins has prejudiced it in popular favor, but though these gum veins (following the concentric rings) are so constant as to be used as means for diagnosing the timber, they are usually so thin and uniform as not to seriously impair its strength. Blackbutt is largely used for shipbuilding. Although such a compact wood, blackbutt is a comparatively rapid grower. The greatest girth of the celebrated Bulli blackbutt is 57 ft. 6 in., and close by are the charred remains of even larger trees. At Gosford there is a tree 156 ft. high and 23 ft. in circumference at a height of 6 ft., and, no doubt, there are very many trees of this size in the colony.

MOUNTAIN GUM (*Eucalyptus goniocalyx*).—This is the spotted gum of Victoria; but it is not to be confused with the spotted gum of New South Wales and Queensland (*E. maculata*). In our colony it goes by several names, viz., Mountain gum, in the Braidwood district; gray gum, east of the Dividing Range; broad-leaved peppermint, at Mudgee, and others. The term gray gum is appropriated by another eucalypt (a red timber), and should be abandoned for the present one, and the Mudgee tree—which yields an inferior timber—may, perhaps, prove to belong to a different species. The name mountain gum would appear to be a convenient one to retain for the timber now under review. It is a large tree, and its timber is stated to be the best procurable in the Braidwood district. It is, in fact, believed to be equal in quality to the spotted gum of the coast, though we require the result of more extended experience on this point. It is a durable, useful timber, used for bridge planking, girders, shafts, and house building, joists, etc.; but, like a number of other good timbers, it is not easily worked. It should be examined with care, as an easy working timber, although comparatively useless, is often substituted for it. I allude to the ribbon or swamp gum (*E. Gunnii*). On the Sugar Loaf Mountain, near Braidwood, the timber attains a height of 100 to 130 ft. and a diameter of 2 to 3 ft. In Victoria, the same species is thought to resemble that of the better known Victorian blue gum (*E. globulus*), and altogether the timber is worthy of consideration by architects, in order that they may come to a conclusion in regard to its value. It occurs near Twofold Bay, and a few other localities in the ranges, near the extreme south coast, but hardly further north than Braidwood.

BLUE GUM of the Southern Ranges (*Eucalyptus Maideni*).—This is a large tree, up to 200 ft. in height, and with an average diameter of 2 to 4 ft. It extends from the boundary of Victoria and New South Wales as far north as Braidwood and the Nelligen districts, being plentiful about Araluen. Up till two or three years ago this species was supposed to be identical with *E. globulus*, the blue gum of Victoria and Tasmania, and, as far as is known, the timbers are very similar. A drawback is that it grows in places mostly difficult of access. The timber is, however, used for fencing, both for rails and posts, also for rough building purposes, and to a certain extent for wheelwrights' work. In the forms of posts it lasts fairly well, and makes excellent rails. From the sample before you it would appear to be a valuable timber. It must not, of course, be confused with the blue or flooded gum of the coast districts (*Eucalyptus saligna*), which is a reddish timber. It would be convenient if the latter were called solely by the name of flooded gum.

GROUP II.—FISSILE TIMBERS.

STRINGY BARK.—*Note.*—Pepperment and messmate, although fair splitters, have been placed in Group 3 for convenience.

The principal characteristic of stringy bark timber is, of course, its fissility, which is taken advantage of to manufacture, at cheap rate, posts, rails, palings, slabs for building, and so on. It is considered to be of little use for piles, but good for girders, and from Bermagui to the Victorian border there is some really good stringy bark timber, strong and tough, and fit for the mill; it is used for house and bridge purposes. Stringy bark timber is a favorite with brickmakers, as it does not give out too much heat, and burns equally. It makes good engine wood, and an excellent charcoal for blacksmith's work. Important to architects is the fact that it is not an inflammable timber, as a burning log has been known to fall on a stringy bark floor and remain there for some hours with no further effect than to char the wood of the floor. It is sometimes used for shingles and laths, and in the south coast districts its saplings are valued for telegraph poles. It is very durable when protected from the weather. There are at the present moment houses in Parramatta the rafters of which were made of stringy bark saplings grown in the locality, and they are as sound as when first put into the buildings 70 years ago. Speaking generally, stringy bark timber may be described as tough, light, and durable, and hence it is used to some extent by coachbuilders. Following is a useful and suggestive report on stringy bark from an English point of view. It is that of A. Ransome, a well known timber merchant: "A very strong, tough wood, with a straight grain, in appearance somewhat resembling American ash. From its great strength and toughness it is well adapted for carriage, cart, and wagon building, wheel work and agricultural machinery, as well as for the framing of railway carriages and trucks. It is also a valuable wood for the stronger description of building constructions, and would make excellent railway sleepers. From the peculiar strength of the fiber of the grain it will not maintain a good surface, as even when perfectly dry the grain rises so as to render it impossible to polish it successfully." We have, in this colony, four kinds of stringy bark recognized as distinct by botanists, yet, although indubitably different trees, their timbers are remarkably similar. As they usually go under the one name of stringy bark, I am compelled to employ botanical names to distinguish them:

1. *Eucalyptus capitellata*, found right along the coast and extending well on to the Dividing Range. Often called the "coast stringy bark," an appellation it should share with *E. eugenioides*, *E. capitellata* and *E. macrorrhyncha* have both of them clusters of fruits which may be likened to diminutive Turks' heads (in this respect they differ from *E. eugenioides*, whose fruits are smaller and more pilular); the former has no stalks to the fruit, while the latter has. The above differences between these three important trees are quite easy to recollect and to apply. On the Blue Mountains it is distinguished from *E. eugenioides* by the name of broad-leaved or silvery stringy bark, in allusion to the frequently ashy gray appearance of its bark.

2. *Eucalyptus macrorrhyncha.*—Found in South Australia and Victoria. In New South Wales chiefly on the ranges in the southern districts, and west of the Dividing Range. Along the Mudgee line it is fairly plentiful, likewise in the New England district. It is sometimes known as red stringy bark, owing to the tinge this timber frequently assumes.

3. *Eucalyptus eugenioides.*—Very common in the coast districts, and extends to the other side of the range. About Mudgee and other places it is known as the white stringy bark, and its timber is considered of superior quality to that of the red stringy bark, *E. macrorrhyncha.*

4. *Eucalyptus obliqua.*—Though little known in our colony, this is the best known of the stringy barks, as it is the principal one in Tasmania (it yields most of the Hobart split palings and fruit boxes), Victoria and South Australia. In our own colony it only comes as far north as Braidwood, and it occasionally goes under the name of messmate.

MOUNTAIN ASH (*Eucalyptus Sieberiana*).—Although ranking among our most valuable hard woods, this timber is of less importance to the architect than it is to the coach builder and wheelwright, who recognize in it a meritorious substitute for American ash. It is a durable timber in damp situations, resisting decay, either as part of a mill wheel or as timbering in a damp mine. It is an easy wood to work, and its

quality appears to be less variable than that of most of the eucalypts. The mountain ash loves high, stony, rocky, mountain ranges, or poor, barren ground, and never takes to grassy localities. It may be quoted as one of the timbers known to be at its best when grown on high land, *e. g.*, blackwood, colonial pine. It is found from the Victorian boundary to the Shoalhaven River, in and over the Mittagong Range, and the Blue Mountains, and also on most of the mountain slopes east of Mudgee.

WHITE ASH (a doubtful species, allied to *Eucalyptus stricta*).—This is really a most valuable timber, considered by some to be in every way equal to American ash. It is brought to Sydney at great expense from the ranges near the Victorian border; is chiefly used by makers of furniture, and were it not that distance from Sydney makes it so expensive, its use would be very largely extended. In color and general appearance, weight (for a hard wood), and freedom of working, it leaves nothing to be desired. As already hinted, architects may design further uses for this meritorious timber. I may mention that in the Bombala district it is used for lining boards instead of pine; also for panels and sash work, as well as for casks and butter kegs.

CUT TAIL (*Eucalyptus amygdalina var.*)—This is a magnificent timber tree found growing in the Delegate district. It grows with a straight bole 200 ft. high, and with a diameter of 6 to 8 ft. Its wood is fissile in the highest degree. It is a splendid timber, and is used locally for all purposes. What the origin of the name is I cannot ascertain. Occasionally the tree also goes by the name of bastard blackbutt. It is considered by botanists to be a variety of *Eucalyptus amygdalina*, further alluded to below.

SILVER TOP (*Eucalyptus amygdalina var*).—An uncommon variety from Mountain Top, Nimitybelle, goes by the above name, and is cut up at the local mills. It is a tough, good working timber, but apparently not liked by tradesmen. We want more practical experience of it. I show samples. At present it is referred, by botanists, to *Eucalyptus amygdalina*.

GROUP III.—INFERIOR TIMBERS.

PEPPERMINT No. 1 (*Eucalyptus piperita*).—This is not a timber of which much can be favorably said. It requires very careful seasoning, as it is liable to cup shakes or looseness between the concentric rings; it is inclined to have gum veins, and it is a poor fuel. At the same time, I believe that, on the principle of "give a dog a bad name," peppermint is not always worthless. Timber from the high table lands and mountains is undoubtedly superior to that of the coast, but very few observations have been published on the timber, and it is to be hoped that some are forthcoming. It is a splitter, though inferior to the stringy bark for this purpose. On account of a certain whiteness of the bark of the trunk, it is occasionally known as white stringy bark. It makes poor boards, and, in fact, is but rarely used for sawn stuff, and it is not very lasting under ground. Its average height is say 80 ft. and diameter 2 to 3 ft. Its bark resembles that of stringy bark, but it is not so fibrous as the latter; the branches are smooth and white. It is found throughout the coast districts and on the Dividing Range. A variety of this tree growing in the Braidwood and Clyde River districts goes by the name of "messmate" and "almond-leaved stringy bark," thus yielding some of the despised messmate, which is sometimes endeavored to be passed off as the more valuable stringy bark. There is a timber known as peppermint or redwood in the south coast, near Dromedary Mountain, which is a really valuable timber. Botanically it is a variety of the woolly butt (*Eucalyptus longifolia*), which of course yields a useful timber. Its timber is red, while that of ordinary peppermint is nearly white.

PEPPERMINT No. 2 (*Eucalyptus amygdalina*).—This peppermint is more abundant in Victoria than in our own colony, and its botanical name is *Eucalyptus amygdalina*. Its leaves yield in the southern colony a large percentage of the eucalyptus oil produced. In New South Wales several trees are included under it, which are recognized as distinct by our timber getters, and I therefore propose to briefly allude to each by its local name. In Victoria, I may mention that when *Eucalyptus amygdalina* attains gigantic dimensions, it is known as mountain ash, and the smaller form is known as peppermint. Both trees are of different species to our mountain ash (*Eucalyptus Sieberiana*) and our peppermint (*Eucalyptus piperita*). I desire to remind you that timber of *Eucalyptus amygdalina* is usually viewed with distrust by architects and engineers, on account of its lack of durability; but in view of the different kinds of timber undoubtedly included in it, it behooves professional men to judge themselves on local experiences as regards durability, and not to condemn a timber because of the species which botanists have provisionally placed it in.

MESSMATE (*Eucalyptus amygdalina*).—Some of the messmate yielded by this species is of a highly ornamental character, owing to its wavy appearance. Of course such timber (of which I show a specimen) is exceedingly difficult to work, but it is really beautiful for panels and some articles of furniture. It is a fair splitter, ranking in this respect with peppermint, to which the timber is very similar. I may remind you that the name originated in the idea that the timber was allied to or messmate of stringy bark.

RIBBON GUM.—We have two gums which go under this name, exclusive of a third which is more generally known as ribbony gum. Neither of the two ribbon gums is of much value for timber. The first is often known as river gum and white gum south of Sydney, and is usually found on the sandy banks of rivers. Its botanical name is *Eucalyptus radiata*, the other is better known as swamp gum (*Eucalyptus Gunnii*).

MANNA OR RIBBONY GUM (*Eucalyptus viminalis*).—As a rule, timber of this species bears a bad reputation in New South Wales, but the name *viminalis* undoubtedly includes more than one species. The tree has a smooth, whitish stem, with bark falling off in patches, and hence it goes by the name of white or gray gum. Under the latter name a good deal of this timber is procured in the Port Stephens district, and it is found very durable under ground. It is flesh-colored. As a rule, timber of this species is weak and liable to gum veins. It is often known as white gum, though I think this name should be reserved for one of those gums whose stems have a more silvery whiteness. As it is the principal yielder of manna in this colony, the name manna gum is an appropriate one. It is found in the coast, mountain, and trans-Blue Mountain districts, but not much north of Port Stephens. From the southern boundary it is found chiefly on the high table land; in the south it is rare near the coast. It is better known as a Tasmanian and Victorian wood.

APPLE GUM (*Eucalyptus Stuartiana*).—This timber must not be confused with ordinary apple tree (largely used by wheelwrights), which is the product of an *Angophora*. It is only mentioned here as one of the pale hard woods to be avoided, as it is a most inferior wood, and shrinks seriously. The vernacular name is owing to the perfume of the flowers, but occasionally it bears the name of "peppermint," "stringy bark," and even "woolly butt." It extends from the Victorian boundary along the high table land to the Braidwood district; and to Mittagong; thence along the coast ranges and eastern table lands to Queensland. It is found at least as far west as Mudgee.

CINCHONA CULTIVATION IN INDIA.

ON the government plantations of the Darjeeling district in Bengal there were at the end of the year (1890–91 season) 4,515,000 cinchona trees, or 156,000 less than in the preceding year. Of the existing trees nearly three-quarters are of the pure quinine-yielding variety, and less than one-third belong to the cinchonine-yielding variety. During the year 367,000 trees were uprooted for their bark or died, while 200,000 were planted out; all the new plantations have for some years past consisted of quinine-yielding varieties. The harvest of dry bark was 294,000 lb. The Darjeeling plantations have now yielded since their formation five million pounds of dry bark for use in India. The factory produced, during the year, 4,031 lb. of cinchona febrifuge and 3,789 lb. of sulphate of quinine; this latter quantity was double the quinine yield of the previous year. The manufacturing operations were conducted entirely by the fusel oil process, and another year's experience has increased the confidence in the simplicity and efficiency of the system. "The quinine has been shown by repeated analyses to be of the highest possible purity."

It is now sold to public institutions and government officers at one rupee per ounce, while the febrifuge is sold at ten annas per ounce. The issues from the factory were 3,837 lb. of febrifuge and 3,789 lb. of quinine. The stock of dry bark is increasing, and the output of the factory exceeds the demand, while local boards are buying for their hospitals inferior quinine at 1¼ rupees per ounce. Steps are being taken to secure the custom of these public institutions; and if the demand on the factory increases considerably, further reduction in the issue price will be possible. The sales and issues of medicine during the year yielded a profit of Rx. * 1,896, after meeting all charges for maintaining the plantations and working the factory. It is proposed in future to manufacture only quinine, and gradually to cease making cinchona febrifuge at the Darjeeling factory.

In the goverment plantations in the Nilgiri Hills in Madras there were at the end of the year 1,762,000 cinchona trees, of which only 51,000 belong to the red bark, or inferior variety; the total is 52,000 more than in the previous year. A crop of 131,000 lb. of dry bark was gathered, of which 96,000 lb. were made into quinine and 4,000 lb. sold. At the end of the year the bark in store was 511,000 lb. The manufacture of quinine by the new oil process was checked by a scare of influenza among the workmen and by partial failure of the vats. Toward the end of the year the vats had been repaired and the manufacture went on; 2,928 lb. of quinine were produced, against an estimate of 4,000 lb. All the quinine made was issued during or after the end of the year; the Ceylon Medical Department took 800 lb., and 64 lb. were issued in paper packets of 5 grain doses for sale or distribution in villages. The retail price of 100 doses was 1¼ rupees, or 3 pie (one farthing) per dose. It is expected that the factory will work full power through the year, and will gradually consume all the dry bark in store.

The quinine is reported by the government quinologist to be "well up to the standard of the British Pharmacopœia;" there was some complaint regarding the appearance of the quinine crystals in earlier parcels, but subsequent parcels were up to the standard in this respect. The paper packets of quinine distributed to villages appear to have been eagerly bought during the fever season. The selling price of quinine has been reduced to 14¾ rupees per pound. The value of the quinine issued during the year and in stock was Rx. 7,300 against a total expenditure of Rx. 7,500 during the year. Experimental plantings of jalap and ipecacuanha are doing well at the cinchona plantation; both climate and soil are said to be specially favorable for jalap tubers.

The area under cinchona on private plantations is returned at about 13,000 acres, chiefly in Madras, Mysore, and Coorg. From the last-mentioned district it is reported that the cultivation of cinchona is being gradually abandoned, owing to the low price of bark in the market, and because the shade of cinchona trees injures the coffee plants. The exportation of cinchona bark from India by sea, which was 3,074,098 lb. in 1888–89 and 1,854,632 lb. in 1889–90, rose again to 2,995,845 lb. in 1890–91.—*Board of Trade Journal.*

ORCHELLA WEED.

SEVERAL of the United States consular reports lately issued have dealt with the subject of orchella weed, from which orchil is made; from these we gather the following particulars concerning this important article of commerce. Originally all of it came from a lichen known as *Roccella tinctoria*, which grows on rocks on the sea coast in the Canary, Cape Verde, and Minorca Islands, the Levant, and on the coast of Sardinia. In the Cape Verde Islands and in the Canaries it also grows on rocks in the interior. In these places it is plentiful but very difficult to obtain, growing as it does on the steep sides of precipitous rocks, where for the best part of the day it is shielded from the direct rays of the sun.

The annual crop of the Cape Verde Islands is about 120 tons, which is all sent to Lisbon; the natives gather it in baskets and sacks and sell it to the merchants in a dry state at 2d. a pound, to which is to be added ½d. per pound export duty and the cost of sacks and packing. The natives are indolent, and if the general harvests are plentiful, the crop of orchella weed drops to 80 or 90 tons; most weed is collected in years of bad harvest. In 1853 orchella weed was discovered in the Galapagos Islands, a group belonging to the republic of Ecuador, consisting of about thirteen islands of various sizes, situated on the equator, 10° to 12° west of Quito and Guayaquil.

Albermarle, the largest of the group, measures 60 miles long by 15 broad. On these islands it grows wild and is only to be had in limited quantities. It is gathered by hand and spread out in the sun to dry and is packed in bales of 150 lb. to 200 lb. for export; 2,000 quintals per annum is the average quantity exported, the price being $5 to $6 American gold per quintal, to which an export duty of $2¾ should be added. The weed gathered in the Galapagos Islands is considered of a better quality than that from the mainland and sells for $1 per quintal more money. The demand is just now very small, owing to the fact that the European markets get their supply mostly from the Cape Verde Islands and the Congo coast. In 1872 Captain John Howard discovered orchella weed in Lower California, and large quantities have been exported from thence.

The business is now entirely in the hands of one man, who holds a grant from the Mexican government, which gives him control over 48° of coast line, practically the whole of the orchella districts, about 3,000 men being employed in the industry of gathering, drying, and packing. A ton of 2,000 lb. costs $43½ in Mexican coin. The trade is in rather a depressed condition just now. It should be mentioned that the Californian weed is considered of a better quality than the Galapagos orchella and than European and African lichens. It takes two years for the lichen to come to maturity.

* The sign "Rx." indicates "tens of rupees."

THE ARROWROOT PLANTATIONS OF COOMERA AND PIMPAMA, QUEENSLAND.*

By H. L. THOMPSON.

THE arrowroot grown in this district is the purple variety—the *Canna edulis*. It sometimes grows to a height of eight feet, bears a pretty scarlet flower, and a dark purple seed pod follows, which is generally sterile. The best variety of arrowroot, the *Maranta arundinacea*, which is grown so extensively in the Bermudas, thrives well in this district; but its cultivation has been almost abandoned, owing to the difficulty of manufacture. This kind attains the height of two feet, and bears at maturity a small white flower somewhat resembling the potato blossom. In the districts of Coomera and Pimpama there are from 250 to 300 acres under cultivation.

The mode of cultivation is as follows: The ground is plowed in ridges of about forty-six feet wide, and thoroughly harrowed and scarified. Nine rows are placed in this, five feet apart, leaving six for the row in which the by-furrow comes. Shallow furrows, five inches deep, are run with the plow, then the smaller bulbs, about the size of a small apple, which are found growing at the bottom of the stems, are placed four feet six inches apart in the drill, and covered by turning a furrow from each side on to the top of the bulbs. Afterward, cultivation is carried on by keeping the ground clear of weeds by means of horse hoes or scufflers.

When the plant reaches the height of about three feet, the space between the rows is turned up with a one-horse plow, the soil thrown toward the plant, and a furrow left in the middle. It requires nothing further till it is dug up for the mill. When the tubers have come to maturity, which is generally in ten months or a year, the crop is ready. The stalks of the plant are then cut off as close as possible to the tubers with a cane knife or strong reaping hook. The tubers are then raised with grubbing hoe or mattock. With all speed they are placed in carts and conveyed to the mill, for the color is seriously affected by being exposed to the sun or weather before grinding. Sometimes as much as 50 lb. weight of tubers is obtained from one plant.

The machinery consists of a six-horse power engine, a root washer, grinding mill, cylinder, sieves for separating the farina from the fiber and pulp, and a centrifugal for drying. The root washer is a trough ten feet long, three feet deep, and two feet in diameter. This has a half-circular bottom, through which a stream of water is constantly running. A spindle having pegs about four inches apart, and of a sufficient length to reach within an inch of the bottom and sides, revolves in the trough. The pegs cleanse the bulbs of all dirt and they gradually work down to one end of the trough. A wooden rake pushes the bulbs out into a continuous belt elevator, and thence they are conveyed to the hopper of the mill. This is a wooden drum two feet six inches on the face and two feet in diameter. It is covered with a sheet of galvanized iron, punched and placed on the burr on the outside. The drum revolves at great speed, and a stream of water falls on it from tanks fixed above.

Thus the bulbs are grated up, the bulbs and the water passing through the sieve No. 1, which is a cylinder eight feet long, with the bottom half perforated with holes about the size of a No. 7 wire nail. Within this a beater revolves, forcing the water and farina through the holes, and, being placed on the screw, the pulp and fiber are forced out at the end. The farina and water pass into sieve No. 2, which is similar to No. 1, only with holes about the size of a large pin head in the bottom of copper.

After this they run along a trough two feet wide, six inches deep, and seventy feet long. The farina is deposited at the bottom of this, and the water passes off. The farina is now dug out and passed through sundry more sieves, washed by hand and in tubs, then finally left to subside. When pretty firm it is taken out and passed through a centrifugal machine. It is now placed on the drying frames. These are wooden frames about six feet six inches long, with marsupial netting and calico stretched upon them. They are placed away from any dust or smoke, and the wind passing

* From the *Pharmaceutical Journal of Australasia.*

underneath, as well as the sun above, aids in the drying process. But the sun and air are not alone trusted with the drying. Drying houses are erected, the one inspected being capable of accommodating 180 frames. This is heated by steam pipes to 140 F. The value and market price of arrowroot depend so much on the color and quality that the greatest care is necessary throughout its manufacture, and only very clear water is used in the washing.

APPARATUS FOR PREPARING THE PLASTER OF PARIS BANDAGE.

By M. G. MCNIVEN, M.D., Marysville, Mont.

As the plaster of Paris dressing is so extensively used, and as the present means for preparing the bandages in small quantities are so unsatisfactory, I have devised an apparatus to facilitate their preparation, which has proved a valuable aid.

It consists of a box, made either of tin or of wood lined with tin. I prefer the latter, as it is more durable. The inside dimensions are: Length, 7 inches; width, 5 inches; height, 5 inches. Its mechanism is very simple, and will be readily understood from the accompanying cuts.

Through one end of the box, about three-quarters of an inch from the bottom, is a horizontal slot (*b*) 4

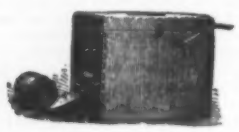


FIG. 1.

inches in width, which slopes downward, to prevent any egress of plaster. The bandage (*a*) passes through this and under a smooth stationary wooden pin (*e*) about a half inch in diameter, thence up to the reel (*d*) at the top, where it is wound.

To operate, first put a bandage in place as directed above, fill the box with plaster to within an inch of the top, wind the bandage up until only two or three inches remain outside of the slot. To the under side of this free end the next bandage is secured, by means of a flat pin, and is then pulled through by a few turns of the crank. When the pin reaches the reel, it is taken out, the bandage already wound being removed, the second made fast to the reel, and so on.

If a piece of bandage be always left extending from the slot to the reel, this will dispense with the primary threading when next used, and also the removal of any plaster from the box. When through using, close

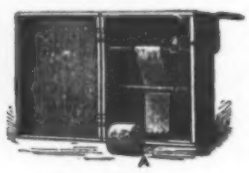


FIG. 2.

the lid, and the remaining plaster will keep dry until wanted again.

By these means the bandages receive a uniform coating of plaster, which is well pressed into the meshes. The efficacy and rapidity of this method, together with its cleanliness, will be much appreciated, especially by those who have many bandages to prepare. —*Inter. Jour. of Surgery.*

ANTISEPTIC MIXTURES.

MM. CHRISTMAS and Respaut, in a communication to the Société de Biologie, recommend several formulæ for antiseptics to be used in dealing with the bacilli of diphtheria, typhoid fever, etc. A one per cent. aqueous solution of any of the first three is said to be sufficiently powerful to kill the germs in one minute, while a 1½ per cent. solution of the fourth is stated to act with fatal effect in thirty seconds.

	(1)	(2)	(3)	(4)
Benzoic acid, gramme	1	1	–	–
Phenol "	8	8	9	8
Chloride of zinc "	1	–	–	–
Oxalic acid "	–	1	–	–
Salicylic acid "	–	–	1	1
Essence of peppermint, drops	–	–	–	10

—*Mon. de la Pharmacie.*

REFINING DENTAL ALLOY.

H. N. WARREN describes a quick method for refining dental alloy, *i. e.*, silver alloyed with from 25 to 30 per cent. of platinum. The latter metal will dissolve in nitric acid when sufficient silver is present, but, in the present instance, only some 10 per cent. of the platinum passes into solution after long boiling. The whole of the silver in the alloy is of course dissolved at the same time, and, on introducing a bar of copper into the solution, both the silver and platinum are quickly replaced. A further addition of nitric acid now redissolves the silver, leaving the platinum untouched. On dissolving the latter, together with the other 15 to 20 per cent. of the same metal left at first, in *aqua regia*, precipitating by an excess of ammonium chloride, evaporating to dryness and igniting, pure platinum remains. The silver is recovered in the usual way by precipitation as chloride; but this method would be useless before removal of the platinum, since nearly a fourth of the amount present would be carried down with the silver chloride.—*Chem. News.*

THE welding and spinning of brass and other metals by what is known as the Bevington process has been indorsed by the Franklin Institute of Philadelphia, to the extent of granting one of the only three medals issued by the society during the last thirty years. This method consists, briefly, in the welding of the metals by forcing them into rapidly revolving dies, where they are softened by frictional heat and united end to end as in ordinary welding, or forced into one homogeneous mass, as solid as if cast into one piece. Brass and copper may thus be welded, which has heretofore been considered impossible. In this manner tubes of all kinds and of any length or thickness can be readily formed, and the ends of short tubes be as neatly joined as if they had been made in one piece.

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